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ABSTRACT

Contemporary Science is a program designed to provide non-academic disaffected students as well as college-bound high school students with a meaningful and positive educational experience in science in order to bridge the gap between science and the citizen in a technological world. The program, designed as a full year elective course, involves the students in activities and projects that reflect concerns regarding current issues in science. The major units of study in this course are matter and energy; meteorology; astronomy; atomic energy; space exploration; population growth; alternate energy sources; health hazards of drugs and smoking; and air, water, and noise pollution. Because of the interdisciplinary theme of the course of study, this program is designed to improve the entire school program by incorporating concepts and skills from other academic areas. These areas include social studies, math, industrial arts, and English. This booklet provides activities that accompany this program. Designed to support the teacher's effort in program implementation, these materials can be used with each unit of study or as supplementary activities. Reproduction masters for transparencies and/or handouts are included. Each activity includes background information, title, purpose, objectives, materials, and detailed procedures. Activity topics include an introduction to contemporary science; the population; intoxicants of man; nuclear energy; astronomy; space exploration; human behavior; air, water, and noise pollution; energy resources; and meteorology. (KR)

ED327413

TOWNSHIP OF OCEAN SCHOOL DISTRICT
CONTEMPORARY SCIENCE

STUDENT ENRICHMENT MATERIALS
SEPTEMBER, 1988

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Written By:
Ronald T. Truex

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CONTEMPORARY SCIENCE

STUDENT ENRICHMENT MATERIALS
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Ronald T. Truex
Twp. of Ocean School District

New Jersey Governor's Teacher Grant Program - 1987
New Jersey State Department of Education

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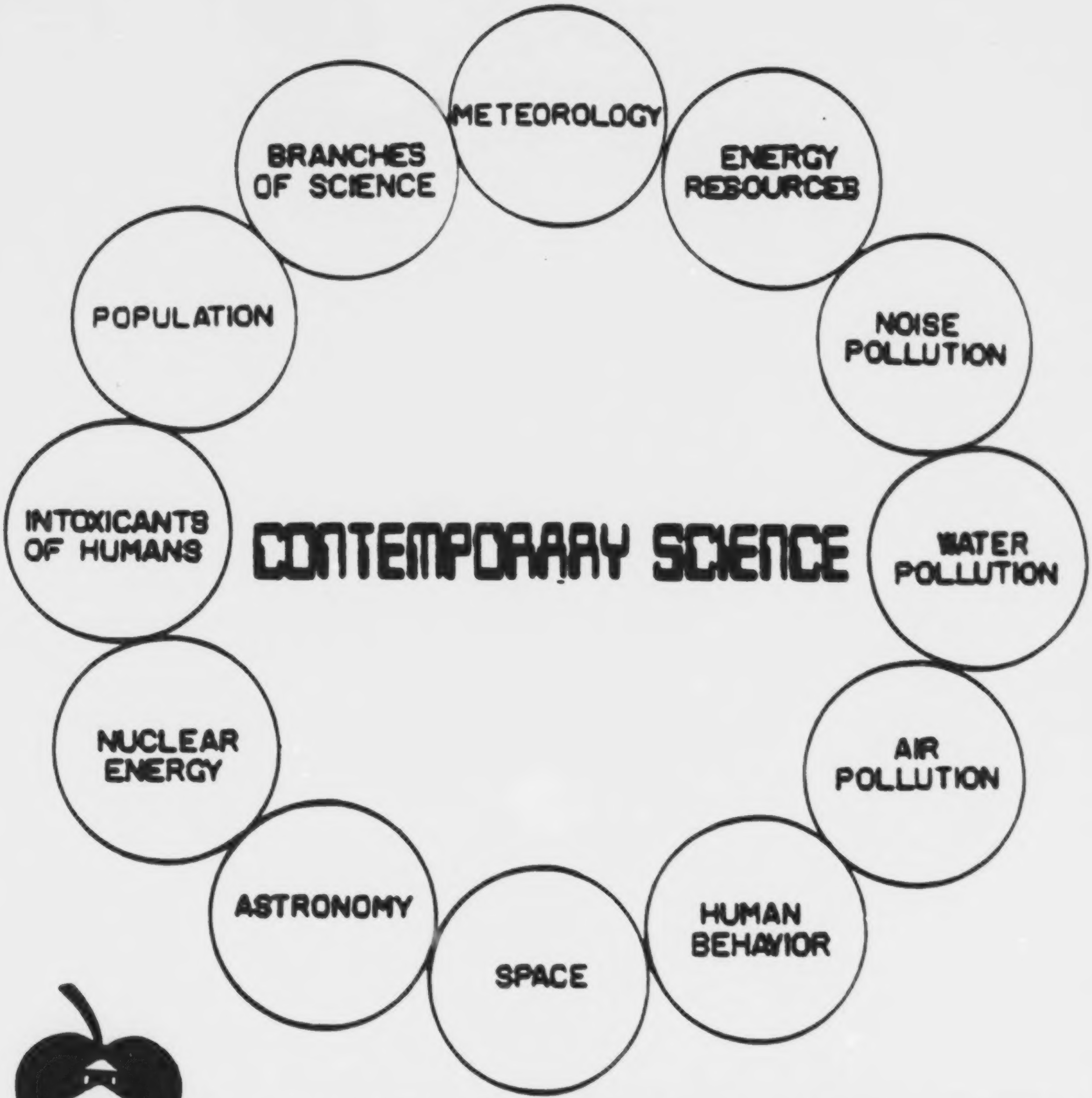
CONTEMPORARY SCIENCE


METEOROLOGY
ENERGY RESOURCES
NOISE POLLUTION
WATER POLLUTION
AIR POLLUTION
HUMAN BEHAVIOR
SPACE
ASTRONOMY
NUCLEAR ENERGY
INTOXICANTS OF HUMANS
POPULATION
BRANCHES OF SCIENCE

New Jersey Governor's Teacher Grant Program - 1987
New Jersey State Department of Education

INTRODUCTION

This program component provides activities to accompany the "Contemporary Science" curriculum guide. Designed to support the teacher's effort in program implementation these materials can be used with each unit of study or as supplementary activities. Reproduction masters for transparencies and/or handouts are included.

Student enrichment materials for each unit are composed of activities that include title, purpose, objectives, materials, and detailed procedures in an easy-to-follow sequence. These activities include opportunities for group work, class discussions, or individual research on topics related to the interaction of science and society.

It should be noted that the material for the units on intoxicants of humans and nuclear energy have been designed to provide extensive background information. All of the materials have been developed to provide the teacher with course structure while maintaining maximum flexibility of implementation procedures.

In order to maintain the "contemporary" nature of the course, teachers are encouraged to update information and activities throughout the school year. Numerous science television programs provide a rich source of information for both the teacher and the student. The effectiveness of many activities can be enhanced by inviting parents to provide feedback and become involved in the program.

The instructional skill of the teacher is the most significant variable that effects learning. It is hoped that the materials provided in this guide will support teachers' efforts in the exploration of these exciting and stimulationg topics.

ACKNOWLEDGMENTS

The production of the Curriculum Guide, Student Enrichment Materials and Program Description for my Contemporary Science course represents the culmination of two years of work. Without the invaluable assistance from colleagues, experts and organizations the completion of the project would have been impossible.

I am particularly indebted to John Lysko, Science Supervisor for the Ocean Township School District, for his suggested course content format, technical and evaluative assistance and editing the project materials.

Acknowledgment is gratefully given to Richard Ponton, Director of Ocean Township Community Services and Dr. Jack Demarest of the Monmouth College Psychology Department for their assistance in evaluation of the project.

To Reed Page, a former Contemporary Science student, my special thanks for his superb graphics work. He was responsible for most of the graphics found in the Student Enrichment Materials.

I wish to thank John Tighe, Assistant Principal and Mike Supko, Industrial Arts Supervisor, for their technical assistance in programing and printing the project materials.

Additional thanks to the Asbury Park Press and the National Aeronautics and Space Administration for use of graphics in the Space and Water Pollution units.

I am indebted to my secretary Debbie Leonard for her dedication throughout the project and especially for the professional and meticulous preparation of all printed materials. Without her perseverence the project would not have reached fruition.

Finally, I wish to thank the Township of Ocean Board of Education, Robert Mahon, Superintendent of Schools, Dr. John Crews, Principal and Dr. Susan Le Gilse, former Director of Special Projects for their approval and encouragement in allowing me to undertake the New Jersey Governors Grant Program.

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Unit I

Introduction to Contemporary Science.

ACTIVITY #1

TITLE: LIBRARY RESEARCH SKILLS

PURPOSE: To provide students with the skills needed to assess and retrieve information from a library.

OBJECTIVE: Students should be able to demonstrate a knowledge of the use of the card catalogue, reader's guide, vertical file, encyclopedia, and reference books.

MATERIALS: Transparency Masters #I-1 thru #I-6.

PROCEDURE: Using transparency masters, the teacher/librarian describes and explains the application of library resources. These resources will be used by the students for selected research activities throughout the course.

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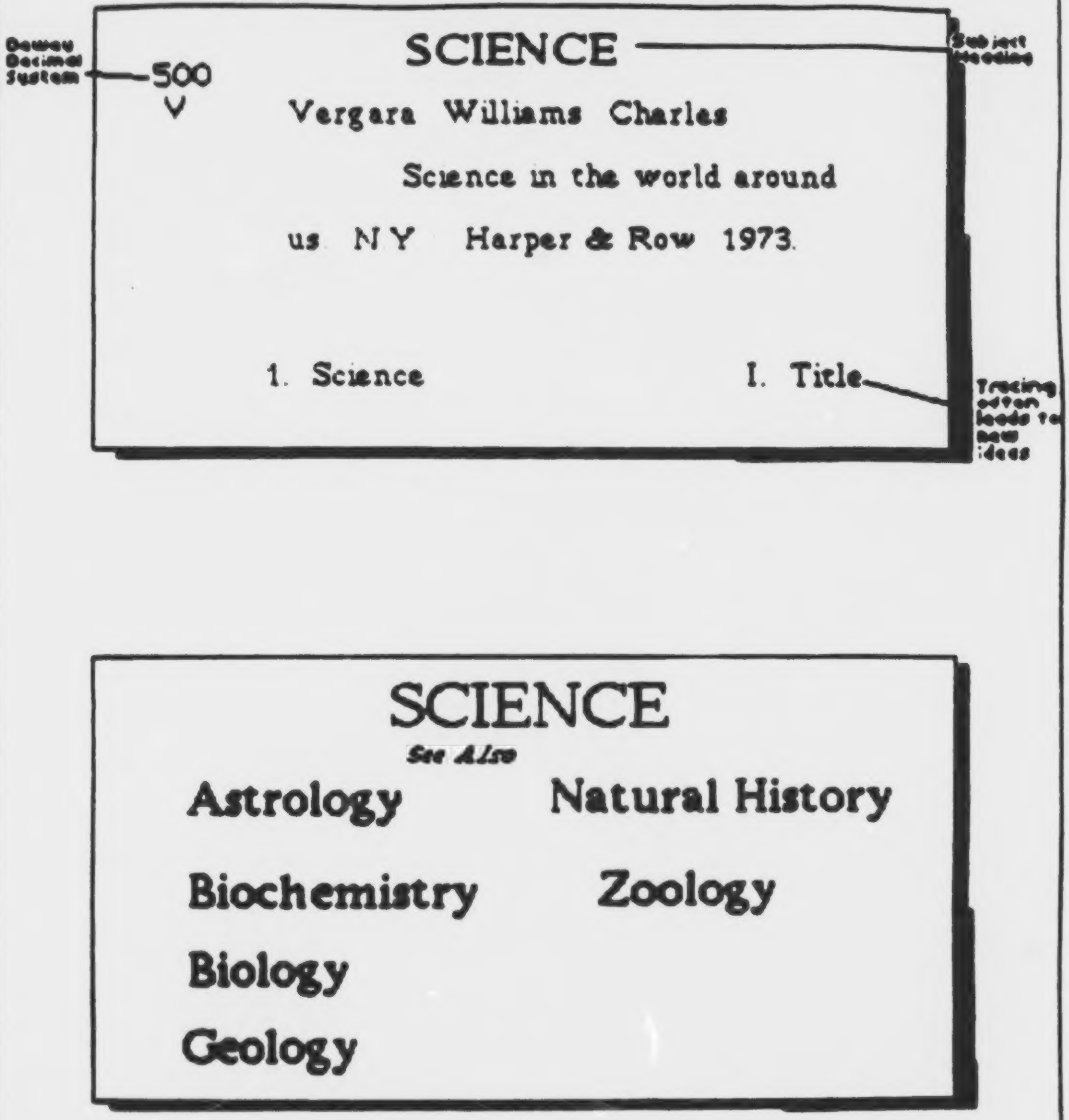
Card Catalog



SCIENCE

500
V

Vergara Williams Charles

Science in the world around us N Y Harper & Row 1973.

1. Science I. Title

SCIENCE

See Also

Astrology
Biochemistry
Biology
Geology
Natural History
Zoology

Dewey Decimal System
Subject Heading
Tracing often leads to new ideas

Card Catalog

POLLUTION

614.7
B

Brown, Michael H.
Laying waste; the Poisoning of America by toxic chemicals. Pantheon, 1980.

1. Marine Pollution 2. Pollution I. T

RADIOACTIVE POLLUTION.

363.7
B

Barlett, Donald L.
Forevermore : nuclear waste in America. Norton, 1985.

1. Radioactive Pollution 2. Refuse & Refuse Disposal I. T

Reader's Guide To Periodical Literature.

Science

See Also

Biology

Computer-Scientific Use

Medicine

National Science Week

Technology

Association Awards presented at annual meeting in Chicago. J. Wrather.

Science 235: 1230-2 Mr 6 '87

See Research

Research

See also

Advertising research

Biological research

Genetic research

Nuclear industry

Biology

See Also

Adaptation

Cells

Clones (Biology)

Cryobiology

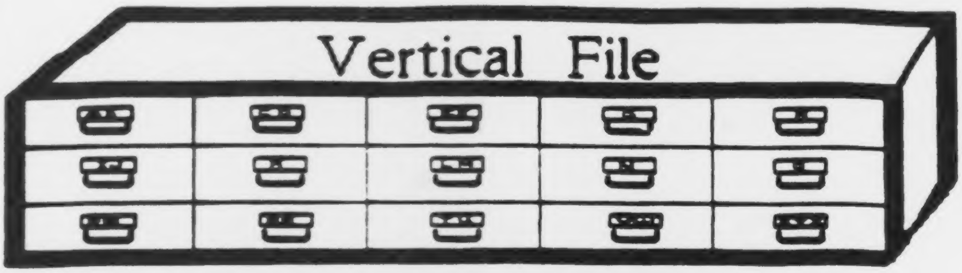
Evolution

Lasers- Biological use

Marine biology

Population biology

MASTER #1-4



Where: Located In the Fiction section.

How: All drawers are alphabetically arranged.

Items may be removed from folders and checked out of library.

Why: Use for recent clippings, brochures and pamphlets.

Easy to use for quick reference.

ENCYCLOPEDIA

General & Specific sets

Use your indexes: they will

Provide you with good ideas.
(Related Information)

Encyclopedia Americana

Collier's Encyclopedia

Encyclopedia Britanica

Popular Science

Mc Graw-Hill Encyclopedia of Science & Tech.

Van Nostrad's Scientific Encyclopedia

Scientific American Readings

Encyclopedia of Biochemistry

Grzimek's Animal Life Encyclopedia

MASTER #1-6

Abridged Dewey Decimal Classification

Pure sciences

500	Pure sciences
501	Philosophy & theory
502	Miscellany
503	Dictionaries & encyclopedias
504	
505	Serial publications
506	Organizations
507	Study & teaching
508	Travel & surveys
509	Historical & geographical treatment
510	Mathematics
511	Generalities
512	Algebra
513	Arithmetic
514	Topology
515	Analysis
516	Geometry
517	
518	
519	Probabilities & applied mathematics
520	Astronomy & allied sciences
521	Theoretical astronomy
522	Practical & spherical astronomy
523	Descriptive astronomy
524	
525	Earth (Astronomical geography)
526	Mathematical geography
527	Celestial navigation
528	Ephemerides (Nautical almanacs)
529	Chronology (Time)
530	Physics
531	Mechanics
532	Mechanics of fluids
533	Mechanics of gases
534	Sound & related vibrations
535	Light & paraphotic phenomena
536	Heat
537	Electricity & electronics
538	Magnetism
539	Modern physics
540	Chemistry & allied sciences
541	Physical & theoretical chemistry
542	Laboratories, apparatus, equipment
543	Analytical chemistry
544	Qualitative analysis
545	Quantitative analysis
546	Inorganic chemistry
547	Organic chemistry
548	Crystallography
549	Mineralogy
550	Sciences of earth & other worlds
551	Geology, meteorology, hydrology
552	Petrology (Rocks)
553	Economic geology
554	Treatment in Europe
555	Treatment in Asia
556	Treatment in Africa
557	Treatment in North America
558	Treatment in South America
559	Treatment in other areas & worlds
560	Paleontology Paleozoology
561	Paleobotany
562	Fossil invertebrates
563	Fossil Protozoa & other simple animals
564	Fossil Mollusca and related
565	Other fossil invertebrates
566	Fossil vertebrates
567	Fossil cold-blooded vertebrates
568	Fossil birds
569	Fossil mammals
570	Life sciences
571	
572	Human races
573	Physical anthropology
574	Biology
575	Organic evolution & genetics
576	Microbes
577	General nature of life
578	Microscopy in biology
579	Collection & preservation of specimens
580	Botanical sciences
581	Botany
582	Seed-bearing plants
583	Dicotyledons
584	Monocotyledons
585	Gymnosperms
586	Seedless plants
587	Vascular cryptogams
588	Bryophyta
589	Thallophyta
590	Zoological sciences
591	Zoology
592	Invertebrates
593	Protozoa & other simple animals
594	Mollusca and related
595	Other invertebrates
596	Chordates Vertebrates
597	Cold-blooded vertebrates
598	Birds
599	Mammals

ACTIVITY #2

TITLE: BRANCHES OF SCIENCE

PURPOSE: To acquaint students with the variety of fields of science.

OBJECTIVE: Students should be able to list and describe the branches of modern science, the applications of science, and the possible future applications of science.

MATERIALS: List of fields of science (Master #I-7).

PROCEDURE: See Master #7.

Contemporary Science
Research Report
Areas Of Science

MASTER #1-7

Procedure

1) Each student must select one area of science listed below.

2) Discuss in a written report of 2-3 pages the following:

A- What is examined or studied in the area of science?

B- What are some of the important findings or experiments currently going on in the area of science?

C- What contributions or benefits will be obtained from that area of science?

3) Using appropiate bibliographical format, list all references.

Suggested Science Areas For Research Reports:

1) Astronomy
2) Meteorology
3) Genetics
4) Chemistry ---- Organic
    Inorganic
5) Botony
6) Zoology
7) Geology
8) Oceanography
9) Ecology
10) Physiology
11) Crystallography
12) Microbiology
13) Paleontology
14) Cryogenics
15) Space Research
16) Astrology
17) Psychology
18) Physics ---- Atomic
    Electrical
    Mechanical
19) Optics

ACTIVITY #3

TITLE: **THE EFFECT OF SCIENCE AND TECHNOLOGY ON OUR DAILY LIVES**

PURPOSE: To realize how technology affects us.

OBJECTIVE: Students should be able to relate the effect of technology on our daily lives.

MATERIALS: None

PROCEDURE: (1) Make a list of the products of technology that you encounter.

- on the way to school in the morning
- during the school day
- during after-school activities
- at home in the evening

(2) Classify your products according to human needs such as:

- water
- food
- shelter
- transportation
- communication
- recreation
- health

TEACHER NOTE:

A typical list of grouped products is as follows:

GROUP	PRODUCTS
water	running water (especially hot water for bathing)
food	frozen and canned foods, snacks, milk and ice cream, fresh vegetables, toaster, stove, regrigerator, microwave oven
shelter	furnace, house, electric blanket
transportation	cars, buses, subways, trains, roads, traffic lights
communication	radio, books, television, pens and pencils, paper, telephone, movies microcomputer
health	toothbrush, vitamins
recreation	sports equipment, stereo system, games

ACTIVITY #4

TITLE: THE RELATIONSHIP OF SCIENCE AND TECHNOLOGY

PURPOSE: To distinguish between science and technology.

OBJECTIVE: Students should be able to provide examples of the application of science and the roll of technology.

MATERIALS: Pictures and/or descriptions of people engaged in science or technology.

Suggested pairs of pictures showing science versus technology include:

SCIENCE	TECHNOLOGY
Galileo observing motion of objects rolling down inclined plane	Young person coasting down hill in soap box racer
Chemist heating test tube over Bunsen burner	Cook using a stove to heat food
Microbiologist looking through microscope	Doctor or nurse immunizing patient(s) against disease

PROCEDURE: (1) Show pictures or read descriptions to students. Are the people pictured or described engaged in science or technology? Use student responses to discuss the relationship and difference between science and technology.

(2) Ask students to collect pictures or write descriptions of people engaged in science or technology and share them with the class.

ACTIVITY #5

TITLE: CAREERS IN SCIENCE AND TECHNOLOGY

PURPOSE: To use newspaper classified sections to see what jobs and careers are available and what training is necessary for them.

OBJECTIVE: Students should be able to identify jobs and careers that require scientific or technological training.

MATERIALS: Classified sections from local and large-city newspapers.

PROCEDURE:

(1) From the classified sections of the newspapers, cut out 10 "Help-Wanted" ads.

(2) List the training necessary to fill each of the jobs.

(3) As a class, discuss the following questions:

- (a) How can an individual obtain the training necessary to change jobs?
- (b) What can students do to prepare for a changing job market?
- (c) Which of the jobs or careers interests you most? Why?

Unit II
Population

ACTIVITY #1

TITLE: RESEARCH REPORT - POPULATION

PURPOSE: To investigate topics and issues related to population growth.

OBJECTIVE: Students should be able to relate population growth to problems of society.

MATERIALS: Master #II-1

PROCEDURE: (1) Have students conduct library research on population issues.

(2) Each student must select one of suggested topics to prepare a research paper of 3-4 pages.

(3) Have students present information from research reports when appropriate during the study of the population unit.

CONTEMPORARY SCIENCE

RESEARCH REPORT - POPULATION

Each student will complete a 3-4 page report on any one of the topics listed below. A complete bibliography must be included at the end of the report.

SUGGESTED RESEARCH TOPICS

1. World population statistics/trends
2. Problems created by overpopulation
3. Birth control methods
4. Birth control devices
5. Abortion - pro and con
6. Economic effects of overpopulation
7. Zero population growth
8. Consequences of teenage pregnancy
9. Alternative methods of population control (e.g., tax incentives, delayed marriage)

*NOTE: DATE OF COMPLETION ______________________________

ACTIVITY #2

TITLE: U.S. POPULATION GROWTH
FROM 1870 TO PRESENT

PURPOSE: To promote an understanding of changes in United States popuation growth.

OBJECTIVE: Students should be able to determine the population changes in the United States from 1870 to 2000.

MATERIALS: Master #II-2
Graph paper, rulers

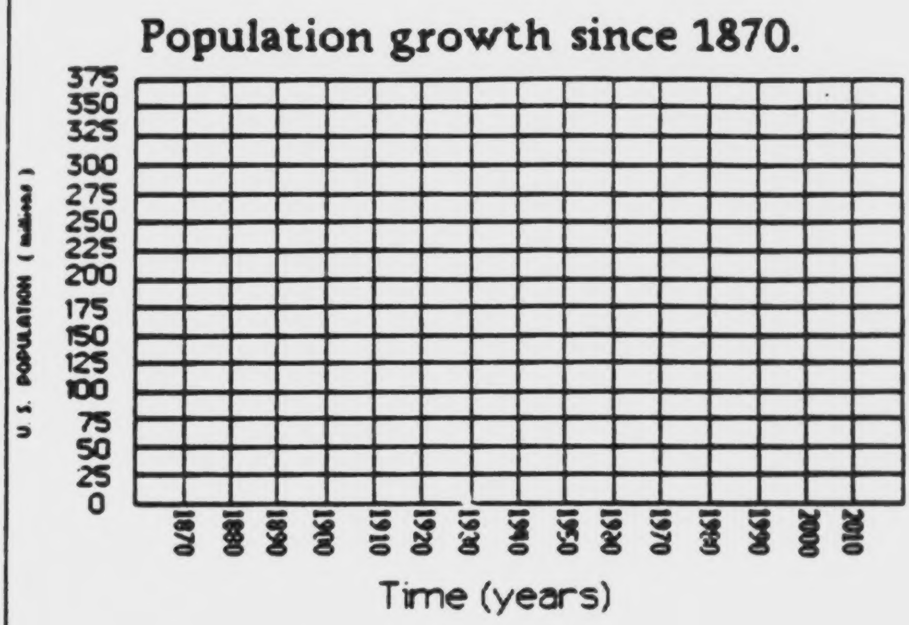
PROCEDURE:

(1) Have students use an almanac to obtain U.S. population figures for the years 1870 to 1980 in ten-year incriments.

(2) Have students complete data chart (see sample)

(3) Graph the data and have students extend graph to project U.S. population in the year 2000.

POPULATION OF THE U.S.


Population growth since 1870.

Use an almanac to determine population changes in the U.S. from 1870 to 1980. Graph the information and estimate the population in 1990, 2000 and 2010 by extending the graph line.

1870 ____________________
1880 ____________________
1890 ____________________
1900 ____________________
1910 ____________________
1920 ____________________
1930 ____________________
1940 ____________________
1950 ____________________
1960 ____________________
1970 ____________________
1980 ____________________
1990 ____________________
2000 ____________________
2010 ____________________

ACTIVITY #3

TITLE: WORLD POPULATION GROWTH

PURPOSE: To depict the geometric increase in world population growth.

OBJECTIVE: Students should be able to construct a graph of world human population growth.

MATERIALS: Masters #II-3 & #II-4
Graph paper, rulers

PROCEDURE:

(1) Reproduce Masters #II-3 & #II-4 and provide each student with a copies of each.

(2) Using the data provided have the students plot data points.

(3) Have students connect data points to construct a line graph of the growth of human population from 8000 B.C. to the present.

(4) Have the students answer and discuss the following questions:

(a) Look at the normal growth curve for living things.

- How does the graph you constructed for the growth of human population compare with it?
- How is it similar?
- How is it different?

(b) If man's growth curve follows the normal pattern for other living things, what lies ahead?

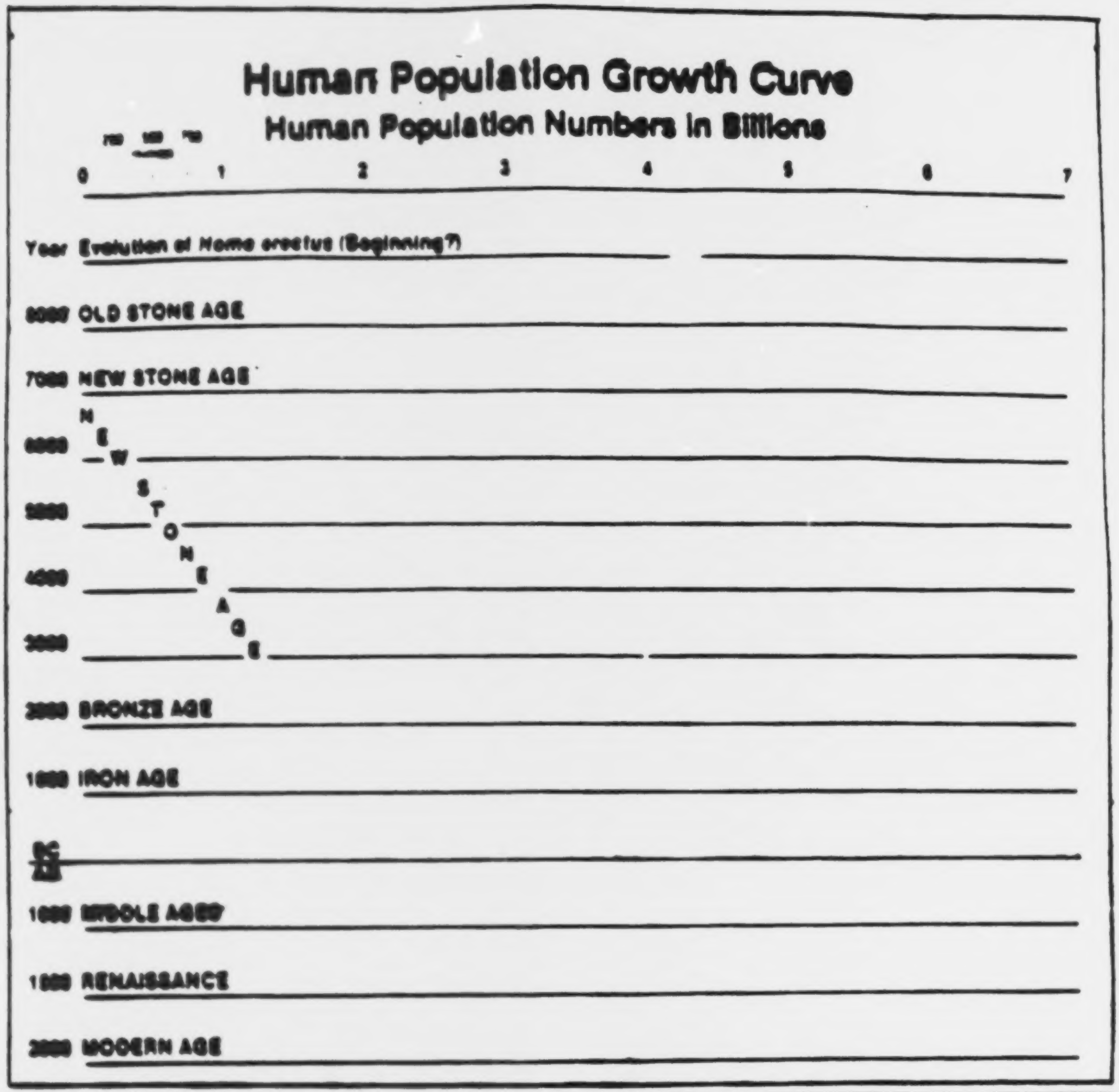
(c) Is it realistic to think man can do anything to control the limits of his growth curve?

(d) What is the ultimate fate of man if his population growth curve follows the normal pattern?

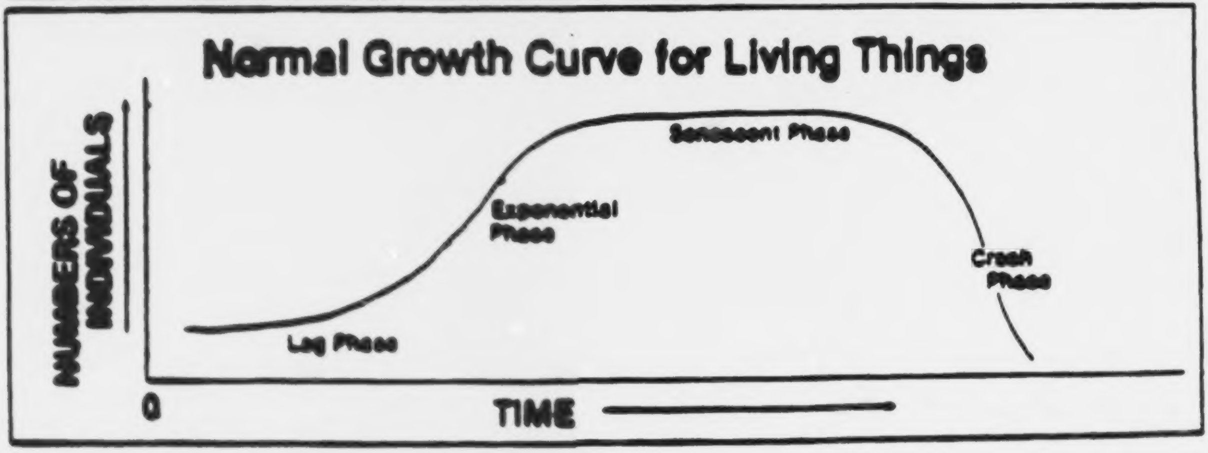
MASTER #II-3

DATA FOR HUMAN POPULATION GROWTH

TIME	NUMBER OF PEOPLE
8000 B.C	10,000
7000 B.C.	15,000
6000 B.C.	30,000
5000 B.C.	50,000
4000 B.C.	100,000
3000 B.C.	500,000
2000 B.C.	250 million
1000 B.C.	500 million
1000 A.D.	750 million
1500 A.D.	1 billion
2000 A.D.	6 billion



Human Population Growth Curve



Normal Growth Curve for Living Things

ACTIVITY #4

TITLE: THE POPULATION EXPLOSION

PURPOSE: To demonstrate the explosive nature of the world's population.

OBJECTIVE: Students should be able to explain the past and future growth patterns of the world's population.

MATERIALS: Master #II-5

PROCEDURE: (1) Prepare a transparency of Master #II-5.

(2) Using transparency have students answer the following guide questions:

(a) How many years did it take the world population to increase from 1 to 2 billion? From 2 to 3 billion?

(b) What is the estimated world population now?

(c) How many years has it taken the world population to increase from 2 to 4 billion?

(d) How many years is it estimated to take the world population to increase from 3 to 6 billion?

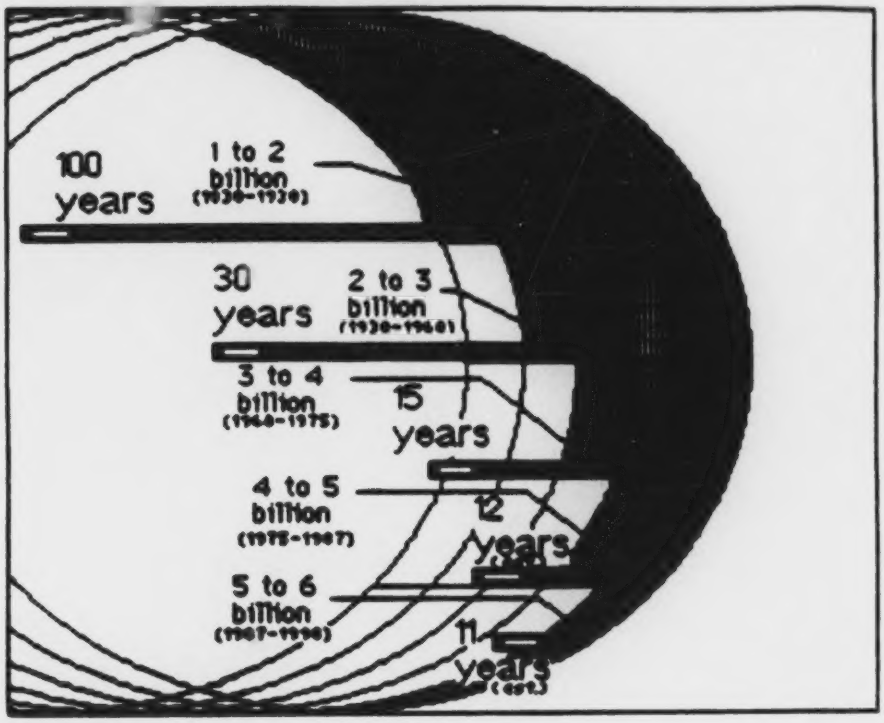
(e) At what rate are we increasing the world population by 1 billion people?

(f) What might be some of the consequences of this population growth rate?

MASTER 811-5

Our Climbing Population.

It took several million years for the Earth's population to reach one-billion, but because of geometric progression each additional billion takes a shorter time to achieve.



Unit III

The Intoxicants of Humans.

ACTIVITY #1

TITLE: EXPERIMENTS ON SMOKING

PURPOSE: To measure the effects of smoking on humans.

OBJECTIVE: Students should be able to measure, chart and analyze smoking data to determine effects of smoke on the body.

MATERIALS: 1 smoker, cigarettes, white handkerchief, wristwatch, Master #III-1.

PROCEDURE: The following demonstrations can be performed by one or two persons at home or in school if permitted. They are useful in illustrating some of the facts that are known about the effect of cigarette smoking on the body.

A - TAR DEMONSTRATION

1 - Have the smoker inhale from a cigarette and hold the smoke in his mouth without allowing it to go into the lungs.

2 - After inhaling, stretch a handkerchief as firmly as possible over the mouth and blow smoke back through the handkerchief.

3 - Have the smoker inhale once more from a cigarette and allow smoke to go well into the lungs.

4 - Place the same handkerchief but at a different location over the mouth and exhale back through once again.

5 - Have students note difference in color of stain.
NOTE: Compare both stains and observe the variation in color of both stains. Theoretically, the difference between the two stains represents the amount of tar that remains in the lungs with each puff of the cigarette.

B - MEASUREMENT OF EFFECTS OF SMOKING

1 - Prepare student copies of Master #III-1.

2 - Demonstrate the method of finding the arterial pulse at the wrist. The pulse can be taken by placing two middle fingers on the right hand on the thumb side of the wrist of the patient. Do not use thumb since the thumb has a pulse and inaccurate readings will result.

(a) The pulse should be taken two or three times to establish a baseline accuracy.

(b) Record pulse rate on chart in column labeled BEFORE.

(c) Have smoker light a cigarette, then take the pulse five consecutive times and record in section labeled SMOKING.

(d) When the cigarette is finished, take the pulse every 3 minutes and record on chart in section labeled AFTER.

3 - The slowing down of the blood circulation can be tested with a clinical thermometer held in the CLOSED hand.

(a) Record the initial external temperature on chart in column labeled BEFORE.

(b) Take continuous readings every 1 minute during smoking and record on chart in section labeled SMOKING.

(c) When cigarette is finished, record temperature at 3-minute intervals in section labeled AFTER.

4 - If possible, check the blood pressure of a smoker before, immediately after and at the 10 minute and 22 minute marks of the smoking exercise.

NOTE: The smoker should show a noted increase in pulse and blood pressure rates. The temperature at first may rise but then will show a drop and hands will become cold and clammy.

Contemporary Science
Effects of Smoking.

	Time (min.)	Pulse rate (Counts / min)	Temperature °F	Blood pressure
	Before			
	0 start			
While Smoking	1			
	2			
	3			
	4			
After Smoking	7			
	10			
	13			
	16			
	19			
	22			

Nonsmoker's Record:

Pulse rate (Counts / min)	Temperature °F	Blood pressure

ACTIVITY #2

TITLE: TEENAGE SELF-TEST ON CIGARETTE SMOKING

PURPOSE: To survey students on their views and attitudes toward cigarette smoking and cigarette smokers.

OBJECTIVE: Students should be able to compare and contrast their views of smoking and persons who smoke to other teenagers nationwide.

MATERIALS: Masters #III-2, III-3, III-4.

PROCEDURE:

INSTRUCTIONS

(1) Read each statement carefully before giving your answer.

(2) These are statements that some teenagers have made about cigarette smoking and cigaratte smokers. Some of the statements are directly related to smoking; some are not as directly related. You may agree or disagree with these statements. After reading each statement, circle the number that most nearly shows how you feel about the statements.

(3) For example: If you strongly agree with the statement, circle the number in the column labeled "STRONGLY AGREE." If you disagree, but not very strongly, circle the number in the column labeled "DISAGREE."

COMPARISON SCORES

(1) Copy each of your eight scores in the spaces below each of the lines, as indicated.

(2) On the chart, make an X at the appropriate place above for each of your scores. For example, if your score is 15, your X will be exactly half way between the top and the bottom. When you finish, you will have eight X marks.

(3) Draw a line to connect the X's.

(4) Now compare your score for each set of statements with the score of the other teenagers nationwide. Remember, in making these comparisons that a high score is not "better" than a low score, as it usually is on tests. The purpose of comparing scores with those of other teenagers is to help you see how you stand on these smoking issues in relation to other teenagers. On the accompanying chart, a line has been drawn to connect the points where each average score falls. If your X on any score is above this point, you are more in agreement with this concept than the average teenager. If it is below, you are less in agreement. On those scores where the average is very high (e.g., Scores 1 and 8) you may be below average but still basically in agreement.

INTERPRETATION

SCORE 1
EFFECT OF SMOKING ON HEALTH

Scores on this set of statements tell how much a person knows about the effects of cigarette smoking on health and how much he believes of what he has learned. The average teenager has a score of 20, which indicates a very high level of acceptance of the health hazards of smoking. If your score is 20 or above, you have learned about the harmful effects of smoking and are concerned about them. A score between 15 and 20 shows concern about the health hazards, but slightly less than the average teenager. Only those with a score less than 15 are not very concerned about it. Either they do not know as much about the health hazards of smoking, or have not really thought about it enough to have formed a strong opinion.

SCORE 2
NON-SMOKER'S RIGHTS

While the score on the statements on Score 1 gives an indication of the effect of the individual, Score 2 deals with the extent to which smoking has an effect on other people. There is a growing feeling that people who do not smoke have the right to breathe clean air that is not polluted with cigarette smoke. Many teenagers agree with this feeling as it is expressed in the statements that go to make up Score 2. The average teenager has a score of 17. A very high score, of 20 or more, is made by a person who is very sensitive to how other people might feel about breathing cigarette smoke. A person who makes such a score would rather not be around smokers, and would like to see smokers kept apart from others in public places. If below 10, the respondent does not feel that cigarette smoke bothers non-smokers. Teenagers who do not smoke have an average score of 19, while those who do show less concern for the rights of others with an average score of 14.

SCORE 3
POSITIVE EFFECTS OF SMOKING

While scores 1 and 2 reflect feelings about the negative effects of smoking, Score 3 looks at the positive effects. Although most teenagers see smoking as very costly in terms of the effects on the individual's health as well as the comfort of others, they also feel that people would not smoke cigaretts if they did not get something out of it. If your score is 20 or above, you believe that people are benefiting a great deal from smoking. The average teenager, with a score of 12, does not see cigarettes as contributing much to a person's enjoyment of life. If your score is 10 or below, you do not see cigarette smoking as having very many positive aspects. There is not as much difference between smokers and non-smokers as might be expected. Smokers have an average score of 14 compared with an average score of 11 for non-smokers.

SCORE 4
MANUFACTURED REASONS FOR SMOKING

Most teenagers, although they believe that smoking is harmful to health, can find reasons for ignoring this fact. They try to make up reasons for overlooking the dangers of smoking, or pretend there are circumstances where there are no dangers in smoking. While they may accept the disadvantages to the individual smoker and to those around him, and may feel that there are few advantages to amoke, some will still try to find reasons to explain why smoking is all right. A high score, 20 or above, says "It can't happen to me," or "Here are the reasons it's all right for me to smoke now." Whereas a low score, 10 or below, indicates that the respondent is not trying to pretend to himself that it's all right to smoke. The average score of all teenagers is only 13, indicating that most teenagers do not try to explain away the disadvantages of smoking. This is true for smokers and non-smokers alike!

In understanding your scores on these four sets of statements, it is helpful to look at them as they relate to each other. If Scores 1 and 2 are high and Scores 3 and 4 are low, you feel that there are many disadvantages to smoking and few advantages. In addition, you have not tried to persuade yourself that it is all right to smoke anyway. This pattern of scores usually is accompanied by a decision not to smoke. Some teenagers, however, while they see more disadvantages than advantages in smoking will still decide to smoke. These teenagers will feel a need to rationalize this decision. They will have high scores on 1 and 2, a low score on 3, and a high score on 4. Those who have low scores on 1 and 2 and a high score on 3 believe that smoking has few disadvantages and can give a lot of pleasure. They think that they have a lot to gain and not much to lose by smoking. They are in danger of becoming smokers, if they have not already done so. High scores on Score 1, Score 2, and Score 3 indicate conflict. People with this pattern see both advantages and disadvantages in smoking. If your scores follow this pattern, you must decide whether the risks to you and the discomfort to those around you are worth the benefits you get from smoking.

SCORE 5
REASONS FOR STARTING

The set of statements that make up Score 5 form a picture of the teenage smoker as other teenagers see him. Whatever reasons teenagers actually have for starting to smoke, this score shows why you think teenagers start to smoke. Perhaps their opinions on why they start to smoke is affected by what they see in advertisements, which show the smoker as popular, attractive to the opposite sex, and, in general, completely accepted by others in his age group. If your score is very high, 20 or above, you think that this is the true picture of the teenage smoker, and that reasons for starting are to enhance social life. The average teenager has a score of 15. Smokers are less likely than non-smokers to believe that these are the reasons teenagers start to smoke. The average score of smokers is 13 compared with an average score of 16 for non-smokers.

SCORE 6
ARE TEENAGE SMOKERS "BAD?"

While Score 5 describes the way teenagers see the taking up of smoking, Score 6 shows a picture of the teenager smoker. This score is based on a group of statements that are very critical of the teenage smoker. A high score (20 or higher) shows agreement with the idea that smokers are show-offs, trouble-makers, are trying to look grown-up, etc. He has very little liking or respect for the smoker, even though he may be one himself. A person who has a very low score (10 or below) does not believe these negative statements about the smokers, or else he refuses to believe them because he doesn't want to think he is this kind of person. The average teenager has a score off 16, with smokers having a lower score than non-smokers, as would be expected. Smokers, with an average score of 13, show that they do not believe that the teenage smoker is "bad." Non-smokers have an average score of 18, showing that they are much more likely to have a negative image of the smoker.

SCORE 7
FEELING TOWARD AUTHORITY

The statements that make up this score deal with how teenagers feel about parents and other people who have authority over them. Score 7 indicates how the individual feels about satisfying his own needs and at the same time meeting the demands imposed upon him by those in authority. The higher the score on this set, the more the teenager likes to turn to his parents for advice and support. Those with low scores want more independence, and very low scores show that the teenager is rebelling against authority. A very high score is 20 and above, and a very low score if 10 or below. Those in the middle express a desire for independence, while realizing that adults are often helpful to them. The average score is 16, with smokers scoring slightly lower and non-smokers scoring slightly higher.

SCORE 8
CAN I CONTROL MY FUTURE?

Although most teenagers want to decide the kind of person they will become, and believe that they can become the kind of person they want to be, some feel this more strongly than others. A high score (22 or more) is an expression of importance to the individual of controlling his own destiny as opposed to being subject to the chances of good or bad luck, or being subject to control by others. It also shows a belief in the ability to exercise this control. The average teenager has a very high score, 21, on this set of statements. There is little difference between smokers and non-smokers.

MASTER SIII-2

	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE
A. Even though lung cancer and heart disease can be caused by other things, smoking cigarettes still makes a real difference.	5	4	3	2	1
B. Cigarette smoke smells bad.	5	4	3	2	1
C. People smoke cigarettes to help them think more clearly	5	4	3	2	1
D. It's okay for teenagers to experiment with cigarettes if they quit before it becomes a habit	5	4	3	2	1
E. Cigarette smoking can harm the health of teenagers.	5	4	3	2	1
F. Cigarette smokers should be kept apart from non-smokers in public places	5	4	3	2	1
G. Smoking cigarettes can help you enjoy life more	5	4	3	2	1
H. Cigarette smoking is harmful only if a person inhales	5	4	3	2	1
I. Even if cigarettes don't kill you, they can cut down on what you might get out of life.	5	4	3	2	1
J. I prefer the company of girls who don't smoke	5	4	3	2	1
K. People who smoke seem to be more at ease with others	5	4	3	2	1
L. There is no danger in smoking cigars or pipes	5	4	3	2	1
M. I believe the health information about smoking is true.	5	4	3	2	1
N. Cigarette smoking should be forbidden inside public places	5	4	3	2	1
O. Smoking cigarettes gives you a good feeling.	5	4	3	2	1
P. Cigarettes low in tar and nicotine can't harm your health.	5	4	3	2	1
Q. There's nothing wrong with smoking cigarettes as long as you don't smoke too many	1	2	3	4	5
R. If I smoke around other people, I take away their right to breathe clean air	5	4	3	2	1
S. Smoking cigarettes seems to make good times even better	5	4	3	2	1
T. Teenagers who smoke regularly can quit for good any time they like	5	4	3	2	1

how to score:

1
Copy in the spaces below the numbers you have circled next to each statement, putting the number you have circled next to Statement A over line A, to Statement B over line B, etc.

2
Add the scores down each column to get your totals. For example, the sum of your scores A, E, I, etc., gives you your score for that column, etc.

___ A	___ B	___ C	___ D
___ E	___ F	___ G	___ H
___ I	___ J	___ K	___ L
___ M	___ N	___ O	___ P
___ Q	___ R	___ S	___ T
(1)	(2)	(3)	(4)

MASTER #III-3

	STRONGLY AGREE	AGREE	NEITHER AGREE NOR DISAGREE	DISAGREE	STRONGLY DISAGREE
A. Most boys start smoking cigarettes because most of their friends smoke.	5	4	3	2	1
B. Teenagers who smoke cigarettes are more likely to be troublemakers than those who don't.	5	4	3	2	1
C. I feel good knowing I can turn to my parents for advice.	5	4	3	2	1
D. Making something of my life is important to me.	5	4	3	2	1
E. Most girls start smoking cigarettes to try to attract boys.	5	4	3	2	1
F. A person who smokes is more of a follower than one who doesn't smoke.	5	4	3	2	1
G. Adults try to stop teenagers from smoking just to show their power.	1	2	3	4	5
H. I use my own set of values to decide what I will or will not do.	5	4	3	2	1
I. Most boys start smoking cigarettes to try to become more popular.	5	4	3	2	1
J. Kids who smoke are show-offs	5	4	3	2	1
K. It annoys me that my parents have so much control over things I want to do	1	2	3	4	5
L. I don't want to get hooked on anything, including cigarettes	5	4	3	2	1
M. If you don't smoke cigarettes, other teenagers put you down	5	4	3	2	1
N. Teenage smokers think they are grown-up, but they really aren't.	5	4	3	2	1
O. I wish I were older than I am now.	1	2	3	4	5
P. I can control the kind of person I will become.	5	4	3	2	1
Q. I am under pressure from my friends to smoke.	5	4	3	2	1
R. Teenage smokers think they look cool, but they don't really.	5	4	3	2	1
S. A teenager should be able to do the things he wants to do when he wants to do them.	1	2	3	4	5
T. I do not want to be just one of the crowd	5	4	3	2	1

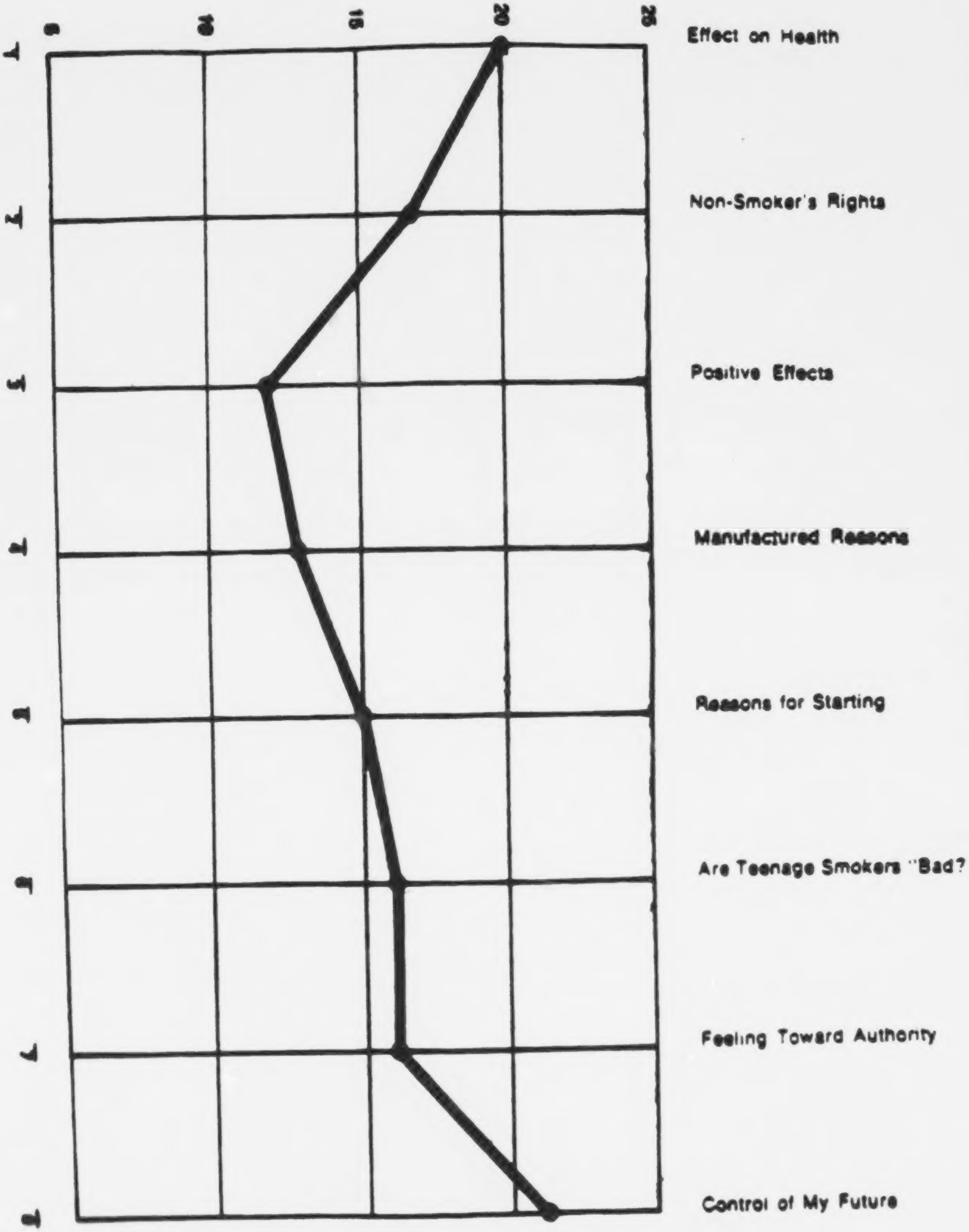
how to score:

1
Copy in the spaces below the numbers you have circled next to each statement, putting the number you have circled next to Statement A over line A, to Statement B over line B, etc.

2
Add the scores down each column to get your totals. For example, the sum of your scores A, E, I, etc., gives you your score for that column, etc.

___ A	___ B	___ C	___ D
___ E	___ F	___ G	___ H
___ I	___ J	___ K	___ L
___ M	___ N	___ O	___ P
___ Q	___ R	___ S	___ T
___ (5)	___ (6)	___ (7)	___ (8)

MASTER #III-4


0
10
15
20
25
Effect on Health
Non-Smoker's Rights
Positive Effects
Manufactured Reasons
Reasons for Starting
Are Teenage Smokers "Bad?
Feeling Toward Authority
Control of My Future

ACTIVITY #3

TITLE: THE CLASSIFICATION AND EFFECT OF DRUGS

PURPOSE: To provide the students with an understanding of the four major groups of drugs and their effects on the body.

OBJECTIVE: Students should be able to identify and describe the effects of drugs on the body.

MATERIALS: Masters #III-5, III-6, III-7, III-8.

PROCEDURE: (1) Prepare transparencies of Masters III-5, III-6, III-7, III-8.

(2) Prepare student copies of the above Masters with the information omitted.

(3) Have students complete their charts as the teacher provides the information for each drug listed.

(4) Using background information provided, characterize each drug group as to the scientific background, medical use and overall effect on an individual.

NARCOTICS

BACKGROUND

The term narcotic, which originally referred to a variety of substances inducing an altered state of consciousness, in current usage means opium, its derivatives, or synthetic substitutes that produce tolerance and dependence, both psychological and physical. Opium, derived from the oriental poppy, Papaver somniferum, is converted into a morphine base and from this substance such drugs as herion and codeine are synthesized.

USE

Narcotics are especially useful in the practice of medicine for the relief of intense pain; they are the most effective analgesics known. They are also used as cough supressants (antitussives) and as a remedy for diarrhea (antidiarrheal).

EFFECT

The opiate-like drugs act as depressants on the central nervous system and can lead to both physical and psychological dependence. They are effective as pain relievers as well as causing lethargy, drowsiness and general confusion. Other effects may include constipation, flushing of the skin, depression of the respiratory system, and constriction of the pupils of the eyes. There is, of course, the possibility of death from overdose.

DEPRESSANTS

BACKGROUND

Man continually has sought relief from pain and suffering, and even in the most primitive societies one can find instances in which man has turned to drugs by utilizing the plant and animal sources in his immediate environment. It was, however, with the development of methods of organic compound synthesis that this search began to yield fruit. The synthesis of barbituric acid from urea and melonic acid produced the oldest of the hypnotic (sleep-inducing) drugs, chloral hydrate. This drug soon supplanted alcohol, opium, and cannabis preparations to induce sedation and sleep. Its popularity declined after the introduction of the barbiturates, but chloral hydrate is still widely used.

The major response obtained from barbiturates is the depression of the central nervous system as they act upon the cerebral centers. They depress brain function and in large doses upset the rhythm of respiration by depressing the brain centers responsible for its maintenance.

USE

When properly prescribed and taken, barbiturates act to relieve tension and anxiety. However, if taken in larger doses they may produce drowsiness or sleep. Other medical uses are for the treatment of high blood pressure, peptic ulcers and spastic colitis.

Tranquilizers such as phenothiazine and reserpine have proved useful in alleviating symptoms of certain major psychotic disorders such as schizophrenia. Some tranquilizers have met with some success in the treatment of certain emotional disorders, relief of anxiety and tension, and also have been used as muscle relaxants. They are probably the most widely prescribed group of drugs in the depressant category.

EFFECTS

When barbiturates are taken in large doses, restlessness, excitement, delirium, and conditions resembling the excitation of an alcoholic may occur. People intoxicated with "downers" are often mistaken for drunks. Disorientation, aggressive behavior, paranoid delusions, and hallucinations often develop in severe cases.

An inevitable characteristic of continued barbiturate use is the development of physical dependence. Physical dependence is a metabolic demand for a certain substance which results in the occurrence of withdrawal symptoms upon discontinued use of the drug. Barbiturate withdrawal can be extremely dangerous and can result in severe convulsions and possible death.

STIMULANTS

BACKGROUND

Stimulants, substances which excite the nervous system, were frequently used by early man for religious and cultural reasons. With the advent of modern pharmaceutical methods, the number of stimulants has proliferated as have our reasons for using them. The amphetamines stimulate areas of the nervous system that control blood pressure, heart, respiratory, and metabolic rates. All of these are increased. Once taken into the body, these drugs resemble epinephrine and norepinephrine which are natural body hormones. Since amphetamines are so similar to these hormones, they can act on the body in two ways: (1) by imitating the natural hormones and their effects on nerve endings; and/or (2) causing an increase in the release of natural hormones. All of the body senses overact and are kept in a state of tension for a lingering period of time.

USE

The stimulating effect that amphetamines have on the body is one of the main reasons for its use in medicine today. Amphetamines also have been used widely in the treatment of hyperactivity in children. This, at first, appears to be paradoxical; but, although the specific mode of action is not fully understood, amphetamines have had a significant degree of success in exercising a balancing effect on hyperactive subjects. One of the side effects which is characteristic of amphetamine use is a loss of appetite. It has proved useful only in short-term weight loss programs since tolerance to the appetite depressant soon develops. Finally, amphetamines have been successful in the treatment of narcolepsy, a rare affliction in which the subject is unable to stay awake for more than a short period of time.

EFFECTS

Heavy users of amphetamines may be prone to sudden violent acts, often for no apparent reason. This results from drug-induced self-centeredness, confusions, distortions of perception, and from the deviant lifestyle of many users. Impure amphetamines often contain materials not easily dissolved in water. These particles can pass into the body and block small blood vessels or weaken their walls. This, in turn, can lead to kidney damage, lung problems, stroke and other tissue injury. Stimulants are not thought to be physically addicting, although tolerance often occurs. Upon the abrupt cessation of their use, certain regular symptoms are common - overeating, severe depression, and fatigue. The duration of these symptoms is about one week. Fatal overdose from stimulants is rare; the majority of deaths associated with abuse of these are caused by related factors - hepatitis, violence, etc.

HALLUCINOGENS

BACKGROUND

The hallucinogenic drugs have existed far back in history due to man's search for an expanded consciousness. Indian tribes have been using "magic mushrooms" and other psychedelic roots and herbs in search of mental visions for centuries. The abuse of hallucinogens in the United States reached a peak of popularity in the late 1960's and a subsequent decline was attributed to broader awareness of their hazardous effects. Their abuse however, re-emerged in the late 1970's.

USE

Except for some evidence that cannabanoids can be useful in relieving the nausea that accompanies chemotherapy, or even in treatment of glaucoma, the hallucinogenic drugs have no known medical value.

EFFECTS

Hallucinogenic drugs, both natural and synthetic, are substances that distort the perception of objective reality. They induce a state of excitation of the central nervous system, manifested by alterations of mood, usually euphoric, but sometimes severely depressive. Under the influence of hallucinogens, the senses of direction, distance, and time become disoriented. A user may speak of "seeing" sounds and "hearing" colors. If taken in a large enough dose, the drug produces delusions and visual hallucinations. Occasionally, depersonalization and depression are so severe that suicide is possible, but the most common danger is impaired judgement, leading to rash decisions and accidents. Persons in hallucinogenic states should therefore by closely supervised, and upset as little as possible, to keep them from harming themselves and others. Acute anxiety, restlessness, and sleeplessness are common until the drug wears off.

Long after hallucinogens are eliminated from the body, users may experience flashbacks-fragmentary recurrences of psychedelic effects-such as the intensification of a perceived color, the apparent motion of a fixed object, or the mistaking of one object for another. Recurrent use produces tolerance, which tends to encourage resorting to greater amounts. Although no evidence of physical dependence is detectable when the drugs are withdrawn, recurrent use tends to produce psychic dependence, varying according to the drug, the dose, and the individual user. It should be stressed that the hallucinogens are unpredictable in their effects each time they are used.

The abuse of hallucinogens in the United States reached a peak of popularity in the late 1960's and a subsequent decline was attributed to broader awareness of their hazardous effects. Their abuse, however, re-emerged in the late 1970's.

NARCOTICS

MASTER #III-6

DRUG	Codeine	Heroin	Meperidine	Methodone	Morphine	Opium	Percodan
COMMON NAME	School Boy	Dope H	Demerol Mepergan	Dose	M Miss Emma	OP	Percs
METHOD USED	Oral	Oral Injected	Oral Injected	Oral Injected	Injected Smoked	Oral Smoked	Oral
PHYSICAL DEPENDENCE	Moderate	Strong	Strong	Strong	Strong	Strong	Strong
PSYCHOLOGICAL DEPENDENCE	Moderate	Strong	Strong	Strong	Strong	Strong	Strong
MEDICAL USE	Analgesic	Analgesic Antitussive	Analgesic	Analgesic Heroin Replacement	Analgesic	Analgesic Antidiarrheal	Analgesic
TIME PRESENT IN BODY		3 Days			3 Days	3 Days	

DEPRESSANTS

MASTER #III-7

DRUG	Amytal	Chloral Hydrate	Librium	Metha-qualone	Nembutal	Seconal	Tuinal	Valium
COMMON NAME	Blue Heavens	Mickey Finn Knock-outs		Quaalude	Yellow Jackets	Red Devils	Rainbows	
METHOD USED	Injected	Oral	Oral	Oral	Oral	Oral	Oral	Oral
PHYSICAL DEPENDENCE	Strong	Moderate	Moderate	Strong	Strong	Strong	Moderate	Moderate
PSYCHOLOGICAL DEPENDENCE	Strong	Moderate	Moderate	Strong	Strong	Strong	Moderate	Moderate
MEDICAL USE USE	Induce Sleep	Sedation Induce Sleep	Relieve Tension & Anxiety	Sedation Induce Sleep	Induce Sleep	Anesthetic Prevent Convulsions	Sedation Induce Sleep	Relieve Tension & Anxiety
TIME PRESENT IN BODY			2 weeks	2-3 days	3 days	3 days		2 weeks

STIMULANTS

MASTER #III-8

DRUG	Benzedrine	Cocaine	Crack	Dexedrine	Meth-amphetamine	Phen-metrazine
COMMON NAME	Bennies White	Coke Show	Rock	Dexies	Speed	Preludin
METHOD USED	Oral Injected	Injected Sniffed	Smoke (freebased)	Oral Injected	Injected	Oral
PHYSICAL DEPENDENCE	Possible	Possible	Possible	Possible	Possible	Possible
PSYCHOLOGICAL DEPENDENCE	Strong	Strong	Strong	Strong	Strong	Strong
MEDICAL USE	Weight Control Narcolepsy Hyperactivity	Anesthetic	None	Anesthetic	Weight Control Hyperkinesis	Weight Control Hyperkinesis
TIME PRESENT IN BODY	2-3 days	2 days	2 days			

HALLUCINOGENS

DRUG	LSD	Marijuana	Mescaline	PCP	Peyote	Psilocybin
COMMON NAME	Acid	Pot, Grass Reefer	Cactus Buttons	Angel Dust Hog		Mushroom
METHOD USED	Oral Smoked	Oral Smoked	Oral Injected	Oral Injected	Oral	Oral
PHYSICAL DEPENDENCE	None	None	None	None	None	None
PSYCHOLOGICAL DEPENDENCE	Slight/ Moderate	Moderate	Slight/ Moderate	Slight/ Moderate	Moderate	Slight/ Moderate
MEDICAL USE	None	Under Investigation	None	None	None	None
TIME PRESENT IN BODY		30 days		3-4 days		

ACTIVITY #4

TITLE: SURVEY OF DRUG AND ALCOHOL USE

PURPOSE: To survey students on the levels of substance use and their attitudes or perceptions regarding the use of drugs and alcohol.

OBJECTIVE: Students should be able to state the extent of local drug and alcohol abuse and compare their position to over 2000 students statewide from 1980, 1983 and 1986.

MATERIALS:

(1) Obtain a copy of the 1987 report "Drug and Alcohol Use Among New Jersey High School Students" from the New Jersey Department of Law and Public Safety.

(2) Administer the 133 question survey instrument at the end of the report.

(3) Conduct student discussions of local results and then make comparisons to statewide survey.

Unit IV

Nuclear Energy.

ACTIVITY #1

TITLE: THE ATOM AND IT'S ENERGY

PURPOSE: To learn the parts of the atom and how nuclear energy is released.

OBJECTIVE: Students should be able to identify and label parts of the atom.

MATERIALS: Master #IV-1

PROCEDURE:

(1) Prepare transparency using Master #IV-1.

(2) Prepare student copies of Master #1 with labels omitted.

(3) Have students label parts of the atom as teacher presents information on the structure of the atom. (See background information).

(4) Have students answer guide questions listed below:

  (a) Name the parts of an atom.

  (b) What is the mass and the charge of each particle found in the atom?

  (c) Compare the number of electrons and protons in a neutral atom.

  (d) What particle determines the identity of an atom?

  (e) What is an isotope?

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BACKGROUND INFORMATION:

STRUCTURE OF MATTER

In order to understand the nature of nuclear energy, the origin of nuclear radiation and the development of nuclear weapons, it is necessary to consider the structure of atoms and their nuclei.

Matter is the term given to objects and substances that make up the world around us. All matter is composed of elements. There are 107 elements known today and these constitute the basic building blocks of nature.

Elements may combine to form molecules which in turn can unite to form compounds. Water is a compound that is made up of molecules that contain the elements hydrogen and oxygen. These molecules can be divided into smaller parts called atoms. The atom is the smallest unit of matter that retains the properties of an elememt amd can enter into anordinary chemical reaction. It is of interest to note that there are 10,000,000,000,000,000,000,000(10^{21}) atoms in one cubic centimeter of water.

ATOMIC ARCHITECTURE

The atom consists largely of empty space. Lord Ernest Rutherford, in 1906, proposed that the atom consists of a positive charge concentrated in a small region at the center of the atom surrounded by negatively charged particles that are in rapid rotation around the central positive charge. This central positive charge he called the nucleus.

In the last decade, it has been established that atoms are themselves divisible into smaller particles. Examination of these particles, even those of different elements, has revealed that all belong to one or another of a few fundamental types.

Three of the more important of these particles are:

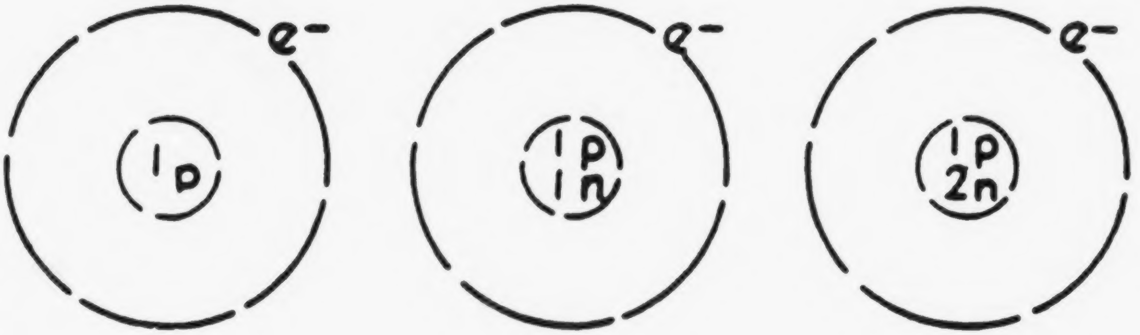
(1) **THE ELECTRON** - A particle with a very small mass and a unit negative charge.

(2) **THE PROTON** - A particle whose mass is 1,836 times that of an electron and unit positive charge.

(3) **THE NEUTRON** - A particle of mass nearly that of a proton possessing no electrical charge.

The nucleus contains a combination of protons and neutrons. Since these are the particles of greatest mass, it is within the nucleus of the atom that its mass is concentrated. All atoms making up the elements are electrically neutral; therefore, each must contain the same number of orbital electrons as there are protons in the nucleus.

Each element is identified by the number of protons found in its nucleus. This number, called the atomic number, is different for each given element. For example, the element iron has a different atomic number from the element hydrogen. The atoms may very in mass because of different numbers of neutrons within the nucleus. These different atoms of the same element are called isotopes. Isotopes of an element contain the same number of protons but a different number of neutrons. Using hydrogen as an example, the chemical properties of the isotopes are the same since the number of orbital electrons is identical for isotopes of the same element. This is illustrated in figure 1.



Hydrogen Mass 1 DEUTEURIUM Hydrogen Mass 2 TRITIUM Hydrogen Mass 3

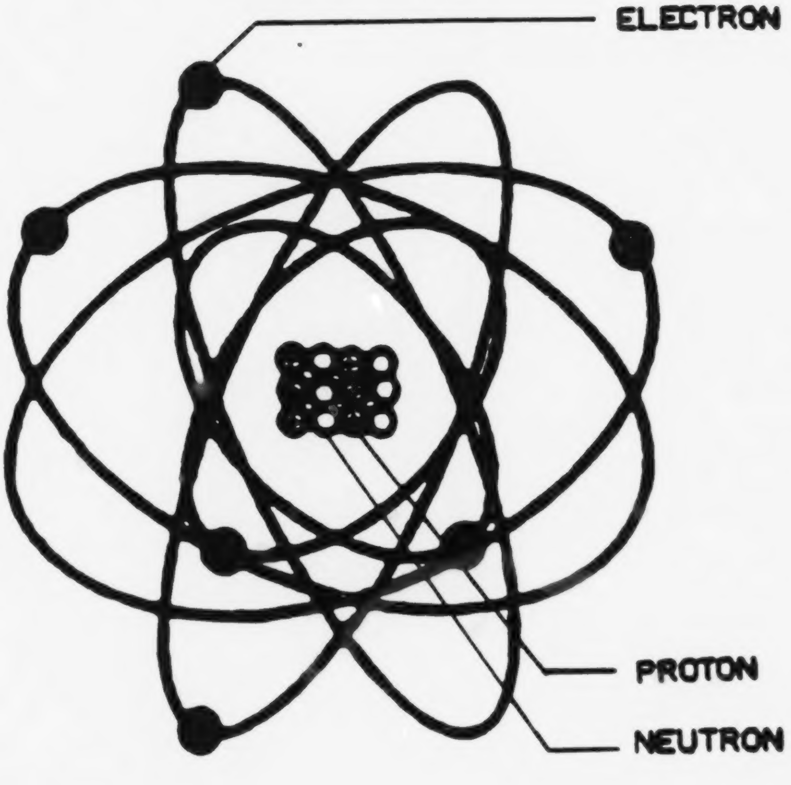
Isotopes of Hydrogen

FIGURE 1

MASTER #IV-1

MODEL OF THE ATOM

Carbon 12


ELECTRON
PROTON
NEUTRON

ACTIVITY #2

TITLE: TYPES OF NUCLEAR RADIATION

PURPOSE: To identify and describe the types of nuclear radiation.

OBJECTIVE: Students should be able to name and describe the four major types of radiation released in various nuclear reactions.

MATERIALS: Master #IV-2

PROCEDURE: (1) Prepare transparency using Master #IV-2.

(2) Prepare student copies of Master #IV-2 with descriptive sections omitted.

(3) Have students complete sections of chart labeled Characteristics, Effects and Protection Needed as teacher presents information on radiation. (See background information).

(4) Have students answer guide questions listed below:

(a) Which form of radiation is least harmful?

(b) Which forms of radiation are most harmful?

(c) How can you protect yourself from radiation? Give examples.

BACKGROUND INFORMATION

TYPES OF NUCLEAR RADIATION

Nuclear scientists have observed a large number of particles that are emitted from the nucleus in various nuclear reactions. The four that are of major importance are:

(1) ALPHA PARTICLES

(2) BETA PARTICLES

(3) GAMMA RAYS

(4) NEUTRONS

ALPHA RADIATION

Alpha particles are helium nuclei having a mass of approximately 4 and charge of plus 2. Alpha particles lose their energy very rapidly as a result of direct ionization of the media through which they are passing. Consequently, alpha particles from radioactive sources are unable to penetrate deeply into the media. A piece of paper or about 11/2 inches of air will absorb alpha particles.

BETA RADIATION

Beta radiation consists of high speed electrons. Their mass is very small, and they carry a unit negative charge. The beta particles, being smaller and more energetic than alpha particles, dissipate their energy less rapidly. This allows them to penetrate to a greater depth before they are absorbed. Nevertheless, thin sheets of metals such as aluminum can be used to absorb this type of radiation.

GAMMA RADIATION

Gamma radiation is different from alpha and beta radiation in that is consists of very high frequency electromagnetic waves. These rays are similar to X-rays but of shorter wavelength. The penetration depth of gamma radiation is considerable. Strictly speaking it is not possible to absorb gamma radiation completely. However, if a sufficient thickness of matter is placed between the radiation source and an individual, the exposure dose can be reduced to negligible proportions. Lead is a material that will satisfy this requirement. Gamma radiation presents one of the greatest human hazards of all the nuclear radiations because of its high penetrating power.

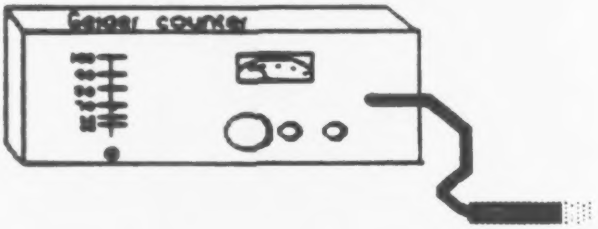
NEUTRON RADIATION

In nuclear reactions such as fission and some fusion reactions neutrons are given off. These released neutrons can penetrate considerable distances through air and appreciable thicknesses of solid substances. As a result of this penetrating power, neutrons can produce harmful effects on all living organisms at considerable distances if shielding is not provided.

In each of the types of nuclear radiation listed, energy is lost by interaction with matter. It is this interaction that can create the human hazards that always give concern when radioactive substances are present.

Types of Radiation

Radiation	Characteristics	Effects	Protection Needed
Alpha	Helium nuclei Travel 1"-3" in air.	Cannot penetrate skin.	None.
Beta	High speed electrons Greater energy than alpha particle. 3"-4" in the air.	Cause skin burns.	Thin sheet of metal. Heavy clothing.
Gamma	High frequency electromagnetic wave. (Similar to X-rays.)	Penetrate body and damage internal organs.	Lead shielding.
Neutron	High speed neutral particle.	Serious damage to all living organisms.	Lead shielding.



ACTIVITY #3

TITLE: NUCLEAR FISSION

PURPOSE: To understand the principle of nuclear fission.

OBJECTIVE: Students should be able to explain and diagram a fission reaction.

MATERIALS: Master #IV-3

PROCEDURE:

(1) Prepare transparency using Master IV-3.

(2) Prepare student copies of Master IV-3 with labels omitted.

(3) Have students label parts of the atomic fission reaction as teacher presents information on the process. (See background information).

(4) Have students answer guide questions listed below:

  (a) Define atomic fission.

  (b) What is the fuel source in the fission process?

  (c) What causes the atom to split?

  (d) What is produced when an atom is split?

BACKGROUND INFORMATION

Nuclear energy is released from an atom through nuclear fission or nuclear fusion. In the fission process, commonly used in today's nuclear reactors, a nucleus of a target material such as uranium-235 is bombarded by a neutron which is absorbed. The absorbed neutron causes the atom's nucleus to split apart or "fission" into two atoms of lighter weight, releasing energy, neutrons, and radioactivity. Fission, then is the splitting of atoms. Fission reactions produce enormous amounts of heat capable of turning water into steam for use in the generation of electricity. The heat is produced from the collision of fissioned particles with other atoms, converting kinetic energy into heat.

"A-bombs" (atomic bombs) are fission weapons. When conditions are just exactly right for a chain reaction, within an extremely small fraction of a second the reaction builds up within a very small space to release enormous amounts of energy. From a relatively small amount of material, there comes a tremendous explosion, many times more violent than is obtained from chemical explosives like dynamite.

MASTER #IV-3

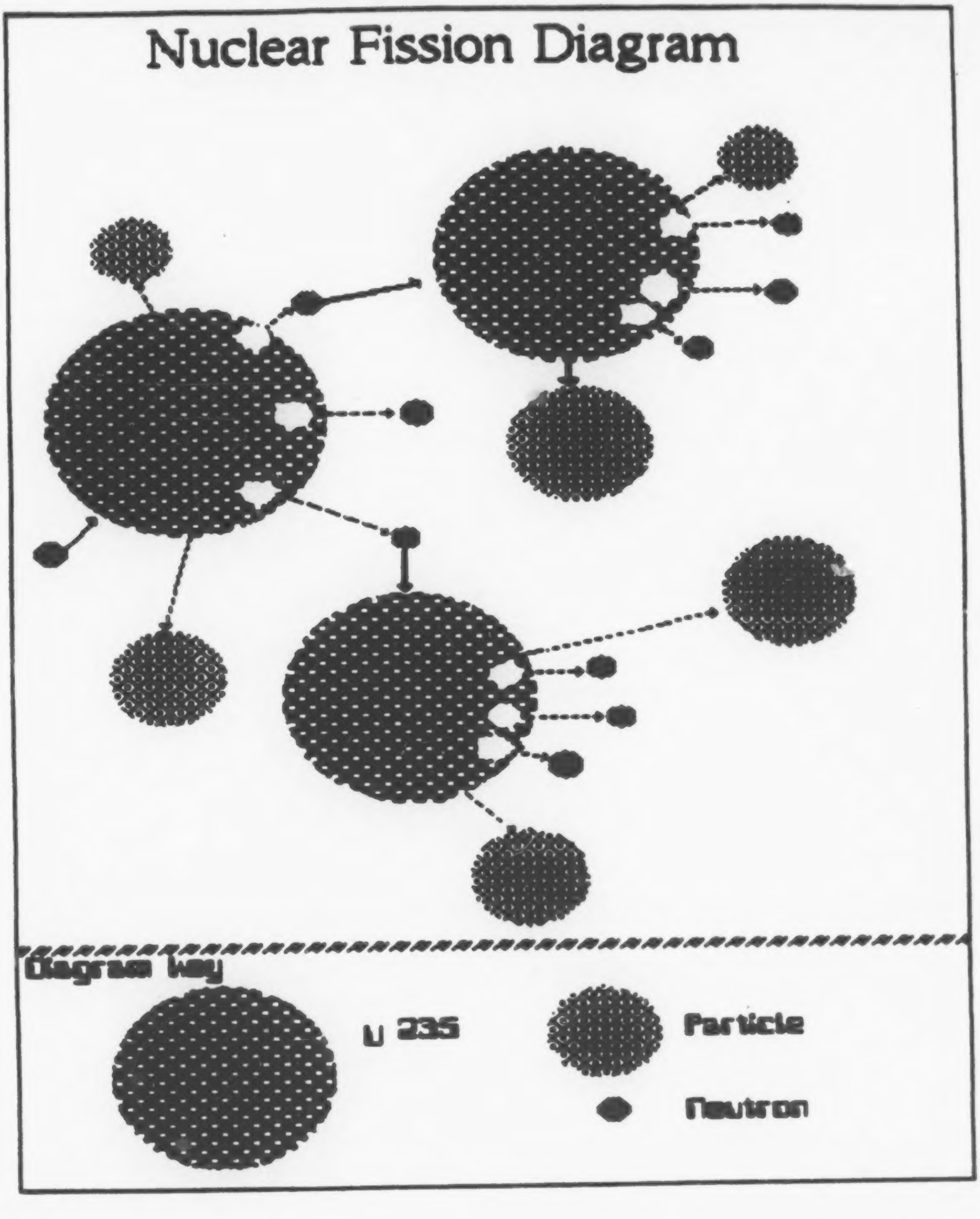

Nuclear Fission Diagram

Diagram Key
U 235
Particle
Neutron

ACTIVITY #4

TITLE: NUCLEAR FUSION

PURPOSE: To understand the principle of nuclear fusion.

OBJECTIVE: Students should be able to explain and diagram a fusion reaction.

MATERIALS: Master #IV-4

PROCEDURE:

(1) Prepare transparency using Master #IV-4.

(2) Prepare student copies of Master #IV-4 with labels omitted.

(3) Have students label parts of the atomic fusion reaction as teacher presents information on the process. (See background information).

(4) Have students answer guide questions listed below:

  (a) Define atomic fusion.

  (b) What is the fuel source in the fusion process?

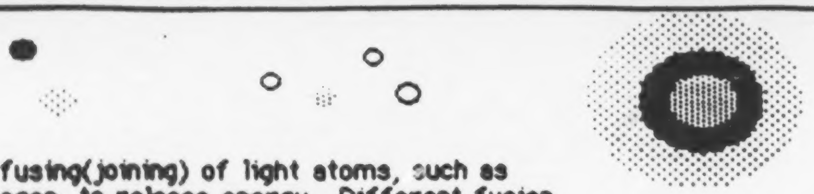
  (c) What is needed to cause the atoms to fuse?

BACKGROUND INFORMATION

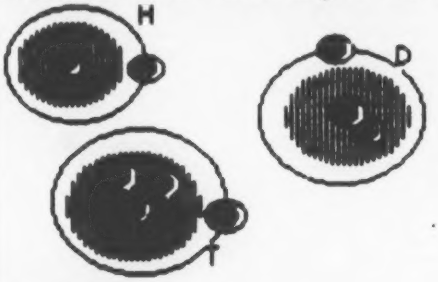
In the second process of releasing energy from the atom, the nuclei of atoms are joined through "fusion," resulting in the creation of a third element, and a free neutron and nucleus. Heat is produced when the free neutron collides with other atoms, again converting kinetic energy into heat. The sun and stars get their energy from the fusion of hydrogen to produce helium. Scientists have been attempting to imitate this process for many years, but it requires extremely high temperatures. Although scientists have been unable to develop a container capable of holdingsuch extremely hot material, one of the more promising efforts involves containing the material within a magnetic field, while being heated to the required temperature. The United States anticipates the eventual construction of fusion power plants.

FUSION

In nuclear fusion, a pair of light nuclei unite (or fuse) together, to form a nucleus of a heaview atom. An example is the fusion of the hydrogen isotope known as deuterium or "heavy hydrogen." Under suitable conditions, two deuterium nuclei may combine to form the nucleus of a heavier element, helium, with the release of energy. The fusion of all the nuclei present in one pound of deuterium would release roughly the same amount of energy as the explosion of 26,000 tons of TNT.

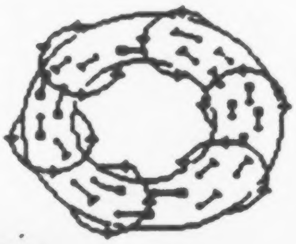


The fusing(joining) of light atoms, such as hydrogen, to release energy. Different fusion reactions occur naturally in the sun and stars.

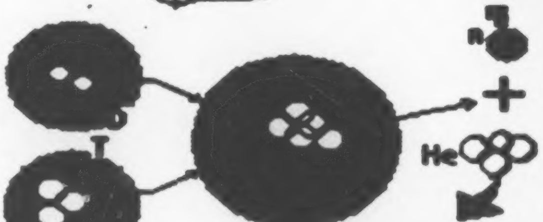


FUEL
The fuel in a fusion reaction comes from hydrogen isotopes, H (hydrogen), D (deuterium) and T (tritium), confined at very high temperatures.

PLASMA
The deutrium & tritium fuel is in a gaseous state called plasma which contains electrons (negative charge) and ions (positively charged nuclei).



MAGNETIC FIELD
A magnetic field confines the movement of the charged particles, preventing them from striking the containment walls, causing them to cool.



HIGH TEMPERATURES
Deuterium and tritium require temperatures of 100 million degrees Celcius to fuse. Otherwise the positively charged nuclei would repel, rather than fuse. The energy of motion from the free neutron (n) and helium nucleus (He) produced in the fusion reaction will be converted into useful energy.

ACTIVITY #5

TITLE: RADIATION DETECTION INSTRUMENTS

PURPOSE: To demonstrate the types of instruments used to detect radiation.

OBJECTIVE: Students should be able to name and describe the various instruments used to detect and measure radiation.

MATERIALS: Master #IV-5

PROCEDURE: (1) Prepare transparency using Master #IV-5.

(2) Prepare student copies of Master #IV-5.

(3) While viewing transparency, present background information and have students answer the following guide questions:

(a) Name six methods used to detect nuclear radiation.

(b) Radiation survey meters and self-reading dosimeters function on the basis of what principle?

(c) Dosimeters are designed to measure what type of radiation?

(d) Survey meters are designed to detect and measure what type of radiation?

(e) Geiger-Muller counters are designed to detect and measure what type of radiation?

(f) How can detection instruments be modified to measure only specific types of radiation?

BACKGROUND INFORMATION

Some of the most useful procedures for the detection and measurement of alpha particles, beta particles and gamma rays are based on Henri Becquerel's discovery that gases become electrical conductors when they become ionized as the result of exposure to radiation from radioactive substances. Nuclear radiation can be detected by ionization chambers, Geiger counters, scintillation counters, crystal conduction counters, photographic film or by means of certain dyes that change color when radiation exceeds a stated limit.

IONIZATION METHODS

The detection and measurement of radiation by ionization is a common method. This method is based on the fact that radiation passing through a gas causes the formation of ion pairs and that these ion pairs can be collected on charged electrodes and measured. Radiation survey meters and self-reading dosimeters used in civil defense operations are based on this principle.

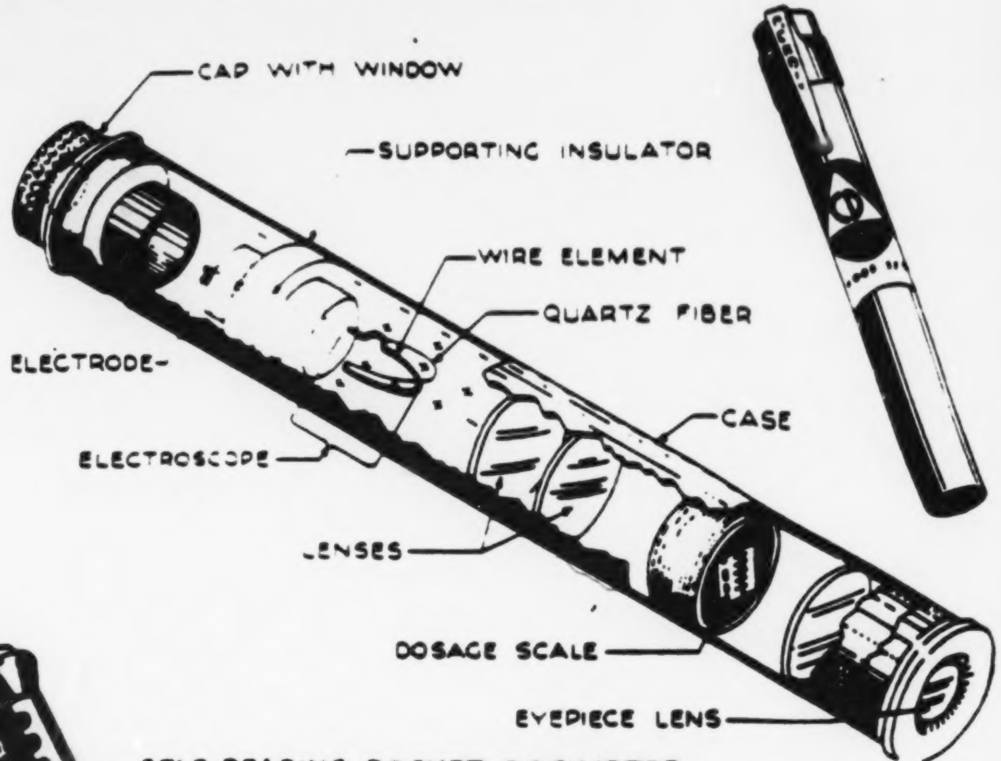
The self-reading dosimeter operates upon the same principle as an electroscope. An electrical charge is placed on a quartz fiber and its parallel supporting rod causing the fiber to be repelled. These are both insulated from the outside container wall. Radiation entering the chamber, encasing the fiber and metal frame, causes the formation of ions which are collected on the quartz fiber or outside wall. A reduction of the charge on the quartz fiber is reflected in the movement of the fiber. If a scale is inserted in the eyepiece and the charge on the fiber is adjusted to zero on the scale, then the movement of the fiber along the scale can be calibrated to indicate the total accumulated ionizing radiation exposure or, as it is more commonly called, the total dose. Dosimeters that are obtained from and used in civil defense are designed to measure gamma radiation only (see figure 1).

Survey meters can be designed to detect and measure alpha, beta and gamma radiation (see figures 2 and 3). Ionization chambers can be used to measure all three types of radiation.

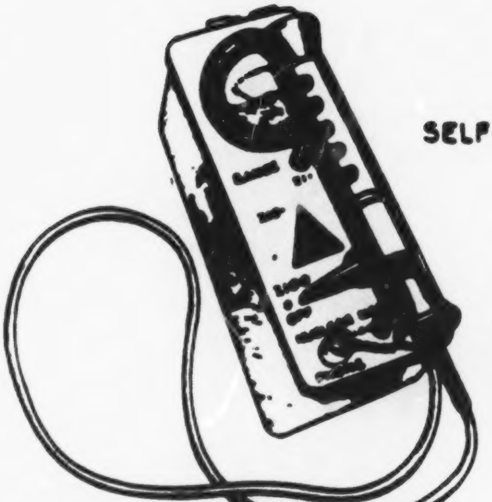
Alpha radiation can be prevented from entering the ionization chamber by inserting a thin piece of aluminum foil in the entrance window of the chamber. Alpha radiation and beta radiation can be prevented from entering by adding a thin piece of lead over the entrance window.

Geiger-Muller counters are widely used in radioactive detection and measurement. These are generally used for beta and gamma rays. The principle on which the operation of the Geiger counter is based is as follows. An electric discharge takes place between two charged bodies when a gas which surrounds the charged body is ionized by a fast moving particle. The essential part of this counter is the Geiger-Muller tube. The construction of the G-M tube is as illustrated (see figure 4).

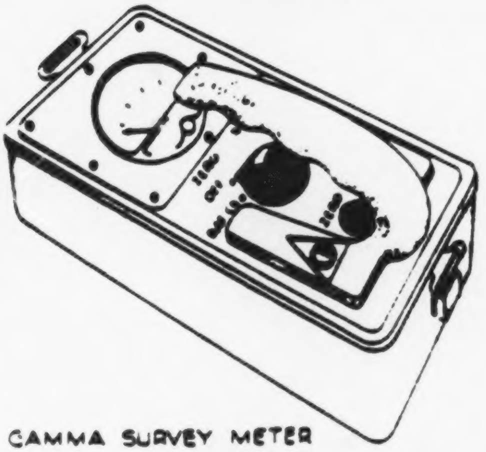
DETECTION OF NUCLEAR RADIATION


CAP WITH WINDOW
SUPPORTING INSULATOR
WIRE ELEMENT
QUARTZ FIBER
ELECTRODE
CASE
ELECTROSCOPE
LENSES
DOSAGE SCALE
EYEPIECE LENS

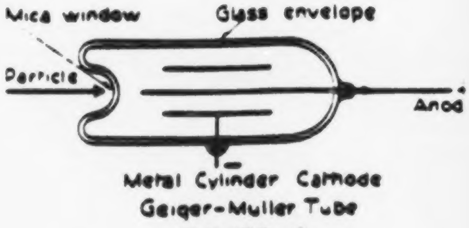
SELF-READING POCKET DOSIMETER
FIGURE 5.



GEIGER COUNTER
FIGURE 6.



GAMMA SURVEY METER
FIGURE 7.


Mica window
Glass envelope
Particle
Anod
Metal Cylinder Cathode

Geiger-Muller Tube
FIGURE 8.

ACTIVITY #6

TITLE: UNITS OF MEASUREMENT OF RADIATION

PURPOSE: To examine the units used to measure radiation exposure.

OBJECTIVE: Students should be able to express the units of radiation measurement and differentiate between the terms "dose" and "dose rate."

PROCEDURE: (1) Write the terms rep, rem, rad dose and dose rate on chalkboard.

(2) Have students define each term in their notebook as teacher presents background information.

BACKGROUND INFORMATION

UNITS OF MEASUREMENT OF RADIATION

In order to express radiation exposure in quantitative terms, it is necessary to describe suitable units of measurement. One such unit is the roentgen (r), named for the discoverer of X-rays, Wilhelm Roentgen. Its advantage is that the magnitude of exposure dose in roentgens can berelated to the expected biological effect that results from nuclear radiation. The roentgen is defined as the quantity of gamma radiation which will form 1.61×10 ion pairs when absorbed in one gram of air. The number of roentgens is not recorded directly. Therefore, detection instruments are so designed that the quantities observed, such as electrical pulses, scintillations or fogging of a photographic film, provide a practical measurement of the radiation exposure in roentgens. Often measurements are made in milliroentgens (mr) which represents one-thousandth of a roentgen.

In order to extend the use of the unit roentgen to all types of radiation, such as alpha and beta particles, protons and neutrons, and to distinguise an individual's "exposure dose" from his "absorbed dose" and/or its biological effect upon him, a new series of units has been defined.

(1) **REP** - Defined as roentgen equivalent physical

(2) **REM** - Defined as roentgen equivalent mammal

(3) **RAD** - Defined as a unit of absorbed radiation dosage that is accompanied by the liberation of 100 ergs of energy per gram of absorbing material.

The exposure to nuclear radiation is usually expressed as a reference dose rate (r/hr). This is the area dose rate in roentgens per hour at or as of one hour after contact. In terms of civil defense, "contact" is construed to mean time of nuclear bomb explosion. At great distances from the site of the initial explosion, the radiation intensity of the r/hr reference dose rate, may never have been present at such locations. The value given serves primarily as a reference for simplifying the calculation, representing the actual exposure intensities and disages, as well as the necessary radiological defense actions that are necessary.

A further clarification of the terms "dose" and "dose rate" would be advantageous at this time. The term "dose" is often used in the sense of exposure dose in roentgens. It indicates the total or accumulated amount of radiation one has received. The term "dose rate" indicates the intensity of radiation to which one is exposed. It is expressed in amount per unit of time. Compare the measuring of "dose rate" to the speedometer of an automobile and "dose" to the odometer.

ACTIVITY #7

TITLE: BIOMEDICAL ASPECTS OF RADIATION

PURPOSE: To depict the biological effects of exposure to radiation.

OBJECTIVE:
(1) Students should be able to distinguish between gamma radiation exposure and skin contamination.
(2) Students should be able to explain the difference between short and long term radiation exposure.
(3) Students should be able to describe the effects of varying amounts of radiation on the body.

MATERIALS: Masters #IV-6 thru #IV-11

PROCEDURE:

ACTIVITY #7A (EXPOSURE VERSUS CONTAMINATION)

(1) Prepare transparencies using Masters #IV-6 and #IV-7.

(2) Present background information and explain the difference between exposure and contamination using transparencies.

(3) Have student write and define the terms exposure and contamination.

BACKGROUND INFORMATION

DANGERS OF EXPOSURE AND CONTAMINATION

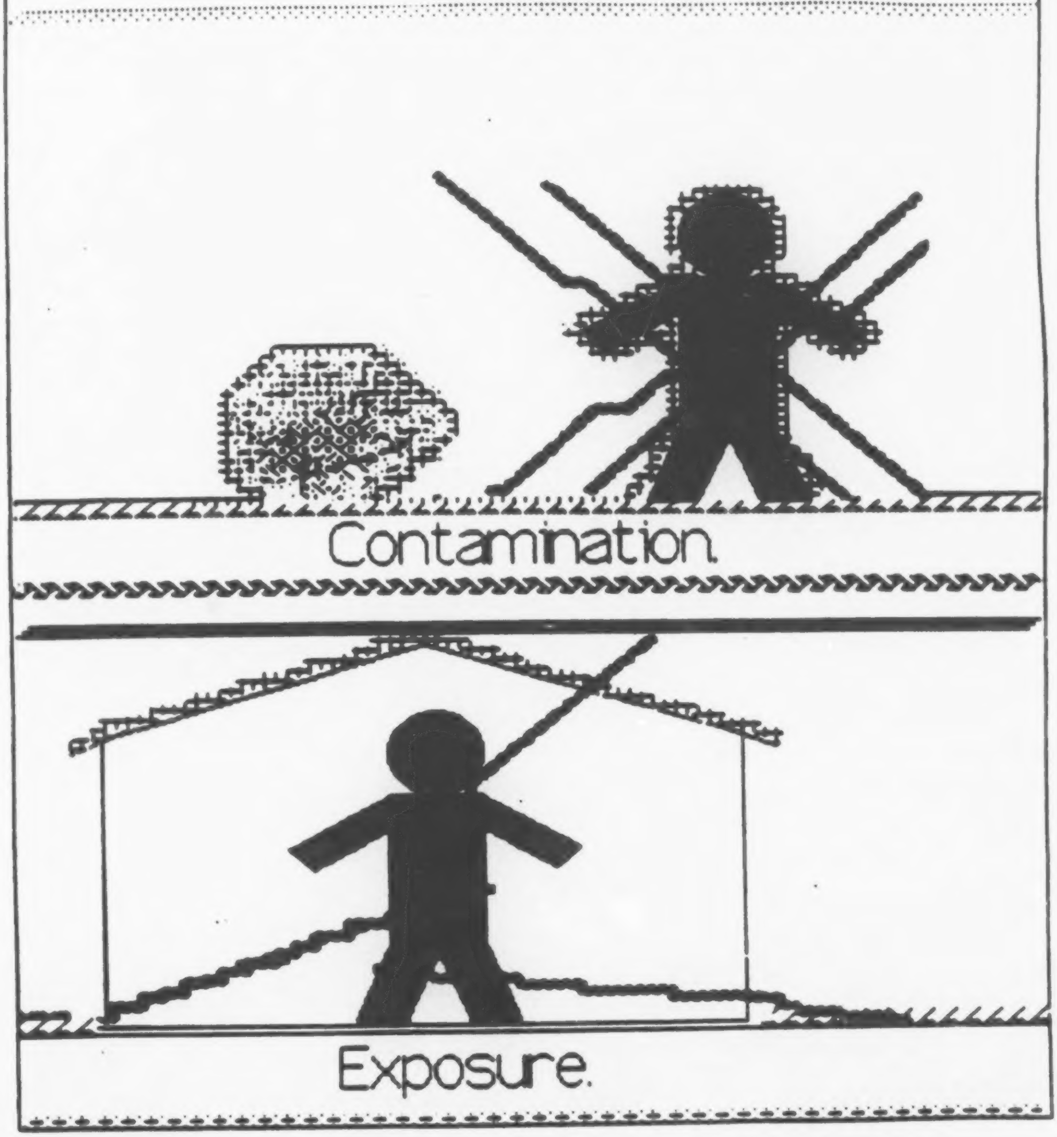
The harmful effects of radiation appear to result from the ionization produced in cells composed of living tissue. As a result of this ionization some constituents which are essential to their normal functioning are damaged or destroyed. In other cases, byproducts formed from ionization reactions may act as cell poisons. Among the observed action of nuclear radiation in cells are: breaking of chromosomes, swelling of nuclei and of the entire cell, destruction of cells, increase in viscosity of cell fluid and increased permeability of the cell membrane. The process of cell division (mitosis) is delayed by exposure to radiation. In many cases cells are unable to undergo mitosis, thereby inhibiting normal cell replacement.

Although it has been established that all radiations capable of producing ionization will cause radiation injury, the various types of radiation differ in the depth that they penetrate and in the degree of injury corresponding to a specified amount of energy absorption. For example, injury from wholebody exposure is due almost entirely to gamma radiation. With skin contamination, the greatest part of the injury is due to the beta component since beta may be absorbed in the layers of the skin. However, it can be easily removed by brushing or washing the contaminated area.

NOTE: It is important to emphasize the difference between exposure and contamination. The following example may be used. A person wearing perfume or cologne may be compared to one who is contaminated by fallout because the substance is on his body. Another who smells the perfume or cologne is exposed and may be compared to one exposed to nuclear radiation. The fallout is not on his body but he is receiving rays of radiation. See Masters #IV-6 & #IV-7.

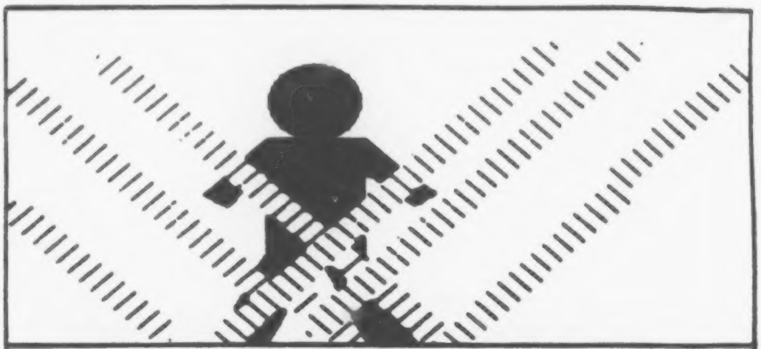
MASTER #IV-6

Contamination
vs.
Exposure

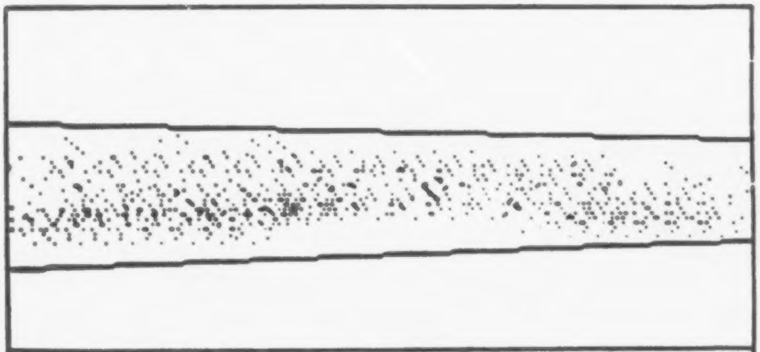

Contamination.
Exposure.

MASTER SIV-7

The Immediate Hazards of Fallout.



Gamma Radiation Exposure.



Skin Contamination.

ACTIVITY #7B (SHORT AND LONG TERM EXPOSURE)

(1) Prepare transparencies using Masters #IV-8 & #IV-9.

(2) Present background information on short and long term exposure. (See background information).

(3) Using transparencies have students write definitions of short and long term exposure in their notebooks.

(4) Have students answer guide questions listed below:

   (a) The effect of nuclear radiation on living organisms depends on what two factors?

   (b) Which would be more harmful - receiving 600 roentgens within 4 days or 600 roentgens over 4 years?

   (c) Why is it possible for the human body to receive small doses of radiation without harmful consequences?

BACKGROUND INFORMATION

SHORT TERM AND LONG TERM EXPOSURE

The effects of nuclear radiation upon living organisms depend not only on total dose (amount absorbed) but also on rate of absorption. These effects are also dependent on whether the radiation is acute or chronic and on the region and extent of the body exposed. There are a few effects, such as genetic effects, that apparently depend only upon the total dose received and are independent of delivery rate. Injury caused by radiation to germ cells is cumulative. For example, if 600 roentgens were received in a single dose, the whole body being exposed, it would prove fatal, whereas there would be no noticeable external effects if the total exposure value had been accumulated over a 30 year period.

The probable reason for the fact that the human body can withstand continual exposure to small doses of radiation from natural sources, without any obviously harmful consequences, is that most of the cells damaged by radiation are replaced by new ones. Whether the injury due to nuclear radiation is reparable or not is dependent upon the natural capability of the affected organ or system to repair itself as a result of damage of any kind.

NOTE: In considering the possible effects of gamma radiation on the body, it is necessary to distinguish between short term exposure and a long term exposure. See Masters #IV-8 & #IV-9.

> A short term exposure is a gamma radiation exposure received over a period of about 4 days or less. Little or no body repair occurs during the period of exposure.
>
> A long term exposure is a gamma radiation exposure received over more than 4 days. Body repair may occur after the first 4 days of exposure.

A Short-Term Exposure

is a gamma radiation exposure

recieved over a period of about

four days or less.

Little or no body repair occurs

during the period of exposure.

A Long-Term Exposure

is a gamma radiation exposure

received over more than

four days.

Body repair may occur

during the exposure.

ACTIVITY #7C (EFFECTS OF RADIATION EXPOSURE)

(1) Prepare transparencies of Masters #IV-10 & #IV-11.

(2) Prepare student copies of Master #IV-10 & #IV-11.

(3) Prepare student copies of Master #IV-11 with all information included.

(4) Have students identify the roentgen level indicated at each arrow and label the effect produced on the body.

(5) Discuss handouts of Master#IV-11 pointing out the effects produced by each roentgen level and the time interval over which symptoms would occur.

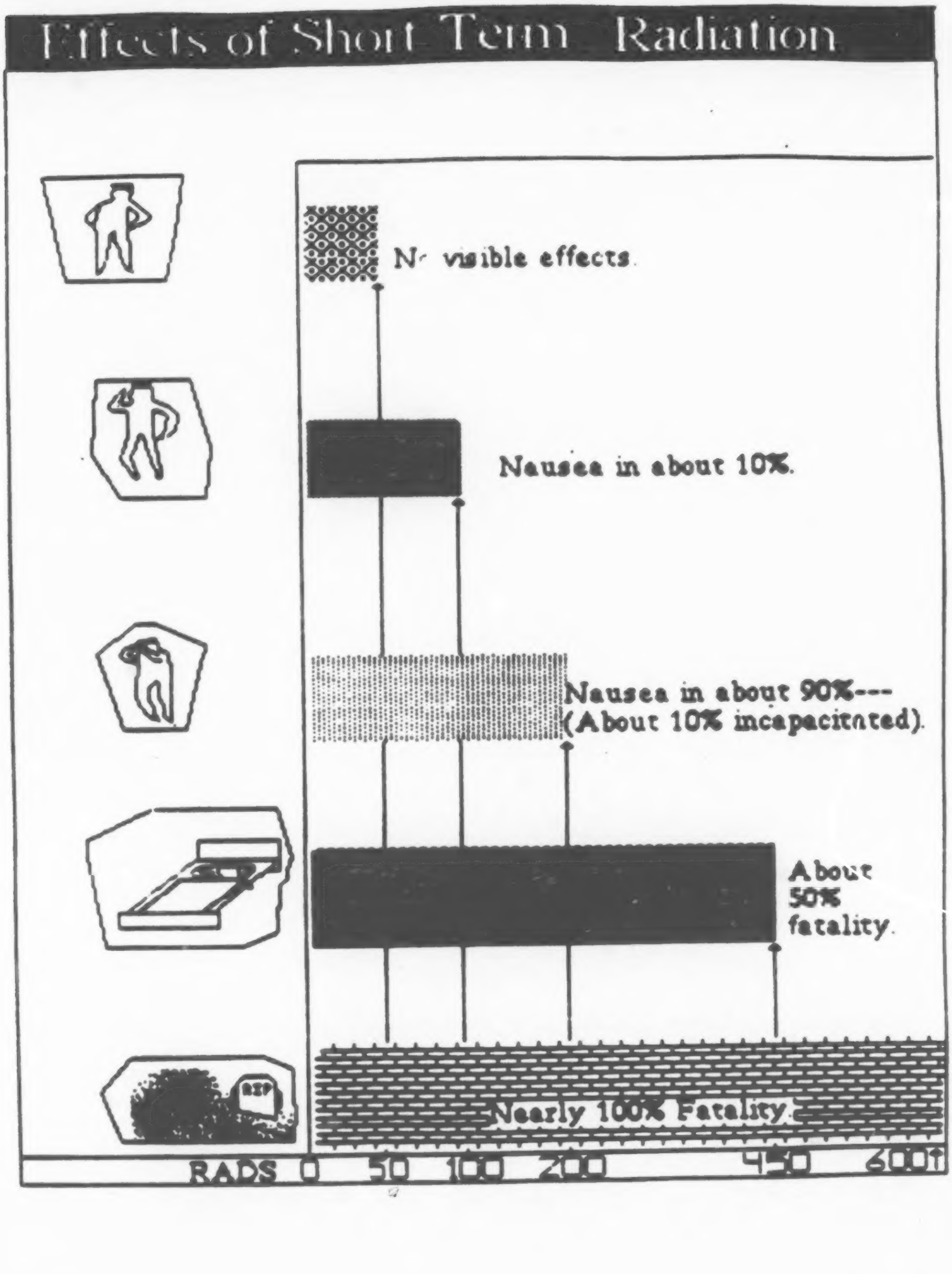
BACKGROUND INFORMATION

CONSEQUENCES OR EFFECTS OF RADIATION EXPOSURE

As has been stated already, the effects of radiation vary with the individual and the nature of exposure but certain rather broad conclusions have been reached. Usually there are four phases in the response of an individual to overexposure from radiation. (See Master #IV-10 & #IV-11). In the first phase, the early symptoms are nausea and vomiting, accompanied by general lassitude. These are similar to those observed in individuals undergoing extensive X-ray radiation treatments. This reaction is termed "radiation sickness." The second phase is one of relative well-being lasting for a varying period of time dependent upon the extent of the initial dose. This period may last from a few days to a few weeks. In the third phase the reaction of the body reaches its height. The survival of the individual depends upon the ability of the system to withstand the reactions of this phase. Some of the symptoms are prostration, loss of appetite, loss of weight, fever, rapid heart action, severe diarrhea, bleeding of the gums and loss of hair. The period of time this phase lasts is dependent on extent of exposure. If the dose has been severe, the individual becomes progressively worse and eventually succumbs. In less severe cases, the individual enters the fourth phase, a period of prolonged convalescence, where there is a gradual recovery. After this convalescence period, which may last up to six months, the individual appears quite normal. There is a possibility of certain consequences that will not be apparent for several years. Among these, apart from genetic effects, are leukemia and the formation of cataracts.

There is evidence that different sections of the body show different sensitivities to radiation. In general, the most radiosensitive areas are the lymphoid tissue, bone marrow, spleen, organs of reproduction and the gastrointestinal tract. The skin, lungs, kidney and liver show intermediate sensitivity. The least sensitive are muscle and full grown bone.

MASTER#IV-10


Effects of Short Term Radiation
No visible effects.
Nausea in about 10%.
Nausea in about 90%---
(About 10% incapacitated).
About
50%
fatality.
RIP
Nearly 100% Fatality.
RADS 0 50 100 200 450 600↑

SUBJECT: SYMPTOMS OF RADIATION SICKNESS

TIME AFTER EXPOSURE	SURVIVAL IMPROBABLE (700 r OR MORE)	SURVIVAL POSSIBLE (550 r TO 300 r)	SURVIVAL PROBABLE (250 r TO 100 r)
	Nausea, vomiting and diarrhea in first few hours	Nausea, vomiting and diarrhea in first few hours	Possible nausea, vomiting and diarrhea on first day
1st Week- - - - -	No definite symptoms in some cases (latent period)		
	Diarrhea Hemorrhage Livid spots on the skin Inflammation of mouth and throat Fever	No definite symptoms (latent period)	No definite symptoms (latent period)
2nd Week- - - - -	Rapid loss of weight Death (mortality probably 100%)	Loss of hair Loss of appetite and general discomfort Fever	
		Hemorrhage Livid spots on skin Nosebleeds Pallor Inflammation of mouth and throat Diarrhea Loss of weight	Loss of hair Loss of appetite and discomfort Sore throat Hemorrhage Livid spots on skin Pallor Diarrhea Moderate loss of weight
4th Week- - - - -		Death in most serious cases (mortality 50 percent for 450 roentgens)	Recovery likely in about 3 months unless complicated by poor previous health or super-imposed injuries or infections.

ACTIVITY #8

TITLE: PROTECTION AND SURVIVAL FROM NUCLEAR ATTACK

OBJECTIVE: Students should be able to explain and measure how time, distance, and shielding are used to minimize the effects of fallout radiation.

MATERIALS: Masters #IV-12 thru #IV-20

PROCEDURE:

ACTIVITY #8A (RADIATION CHARACTERISTICS)

(1) Have the students define the meaning of "Protection". (See background information).
(2) Have the students list characteristics of radiation.

BACKGROUND INFORMATION

INTRODUCTION

Protection is that which preserves or shields from injury. Protection from radiation injury is a matter of common sense application of certain basic principles. Once they are understood, these principles can be applied individually or collectively to reduce or eliminate danger from radiation.

RADIATION DEFINED

1. Radiation is the emission of a form of energy in all directions from a common source.
2. Heat and light are the most common types of electromagnetic radiation.
3. Nuclear radiation is similar to radiation of heat and light in many ways.
   a. It travels in straight lines and with the same speed.
   b. Excessive exposure can damage body cells.
   c. It is possible to provide protection against it.
4. Nuclear radiation differs from radiation of heat and light.
   a. It cannot be seen, felt, smelled, or tasted.
   b. It has much greater penetrating power.

ACTIVITY #8B (PROTECTION FROM RADIATION)

(1) Have the students list basic elements of protection against external nuclear radiation. (See background information).

(2) Have the students list characteristics of radiation for which protective measures can be applied.

BACKGROUND INFORMATION

PRINCIPLES OF PROTECTION

(See Master #IV-12)

The basic elements of protection against external nuclear radiation are the same as those for other types of radiation. One protection from sunburn is to limit the time during which the body is exposed to the sun's radiation. Protection from the heat of a fire is readily provided by moving away from it, that is, by putting distance between oneself and the source of the heat radiation. Protection from the sun's rays can also be provided by putting up an umbrella. Protection from the heat of a fire can be provided by putting something between onefelf and heat rays from the fire. The umbrella or whatever is put between oneself and the source of the radiation acts as a shield. The three basic elements of protection then are time, distance, and shielding. All of these can be aopplied in providing protection from gamma radiation, either singly or in combination.

PERTINENT CHARACTERISTICS OF RADIATION

Characteristics of radiation which are pertinent to application of protective measures are:

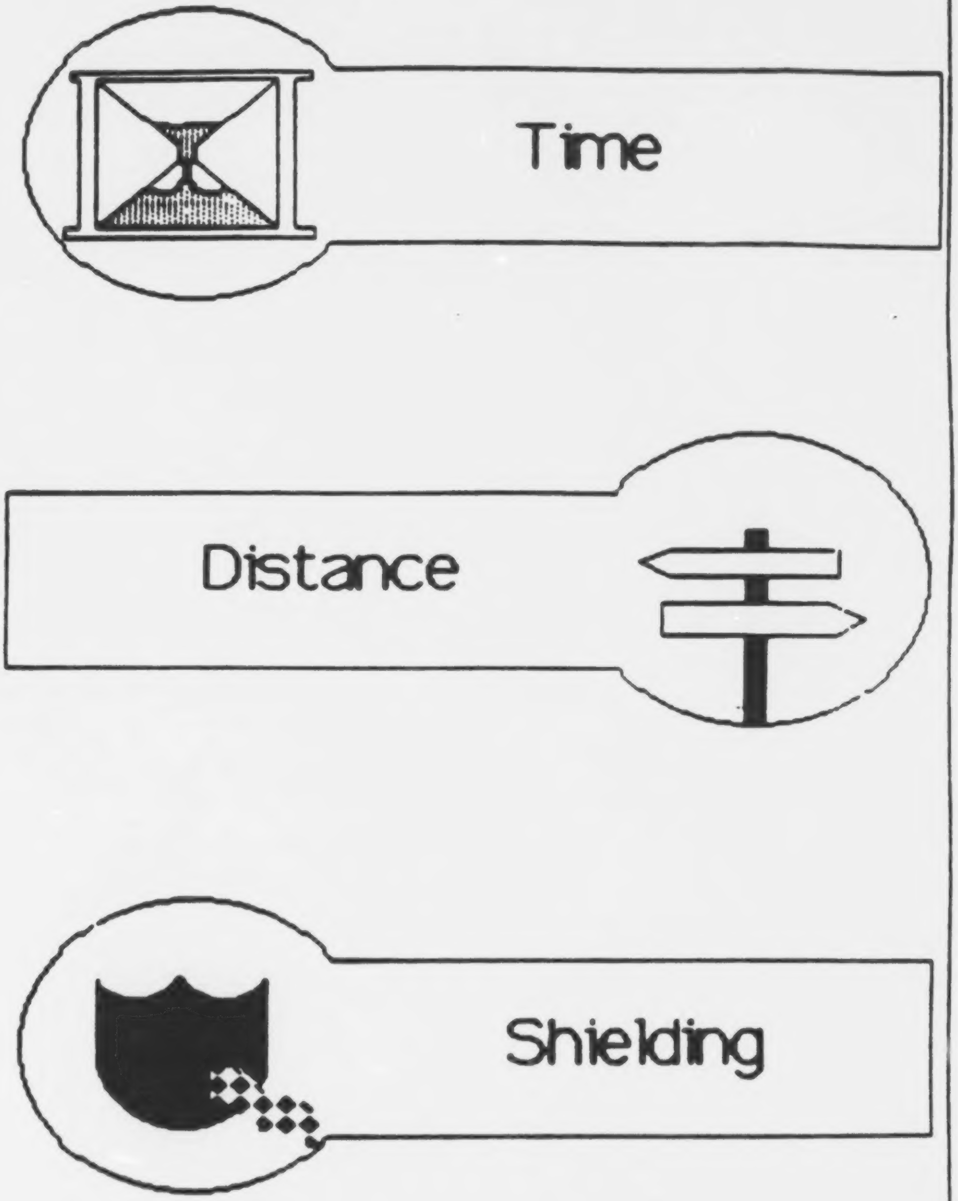
(1) Radiation decays with time.

(2) Radiation decreases with distance from the source.

(3) Materials absorb radiation.

MASTER #IV-12

Principles of Protection.



Time

Distance

Shielding

ACTIVITY #8C (PRINCIPLE OF TIME)

(1) Prepare transparencies of Masters #IV-13, #IV-14, #IV-15, #IV-16. (Review background information).

(2) Show transparency of Master #IV-13 and discuss how in time ice melts, a flashlight loses brilliance and a fire produces less heat and light.

(3) Show transparency of Master #IV-14 and have students define the terms isotope and half-life.

(4) Have students research the half-life of other radioactive isotopes.

(5) Show transparency of Master #IV-15 depicting radiation decay. If possible, make student copies with plot of decay rate omitted. Have students make plot as the data is provided by instructor.

(6) Show transparency of Master #IV-16. Explain radiation decay using the 7:10 rule.

(7) Using Master #IV-17 have students calculate the rate of decay for examples #4, #5, #6.

BACKGROUND INFORMATION

RADIATION DECAYS IN TIME

1. Just as ice melts in time, flashlight brilliance decreases with time, and the heat from a fire decreases as the fire burns down, radiation decays with time. (See Master #IV-13).

2. The total amount of radiation from fallout decreases with time because fallout contains many different kinds of radioactive materials--isotopes they are called. Some of these "die" more quickly than others.

3. To understand this, consider the animals on Noah's ark. (Master #IV-14). Each kind of animal has a different life expectancy or average length of life. The average mouse, for example, lives about two years while the average cat lives about ten years. Other animals have different average life length. If the rain had lasted long enough, the shorter lived animals would have begun to die off. If no new animals had been born, the total number of animals on the ark would have decreased more and more as time went on.

4. Theoretically, radioactivity never dies completely. However, it does half die and it does this systematically. Each radioactive isotope loses half of its intensity in a definite period of time. This period of time is called its half-life.

5. For example, the half-life of the radioactive isotope Sodium 24 is 15 hours. This means that at the end of 15 hours, the radioactivity will be only half as great as it was at the beginning of this period. At the end of another 15 hours, the intensity will again be decreased by half. It will then be only one-fourth as great as it was originally. This goes on indefinitely. While in theory the radioactivity will never totally die out, it will become so infinitesimally small that it will be insignificant as a hazard.

6. Some radioactive isotopoes have half-lives of only seconds or minutes. Others have half lives of many years.

   The half-life of another radioactive isotope, Strontium 90, is approximately 28 years. Thus, it will take this isotope 28 years to lose half of its original intensity and another 28 years to reduce to one-fourth of its original intensity.

7. Fortunately most of the radioactive isotopes in fallout are relatively shortlived and the total amount of radiation decreases rapidly in the first few hours. The rate of decay becomes less rapid as time goes on because the isotopes with short half-lives will have lost their strength.

8. The effects can be shown clearly by this chart of radiation decay. (See Master #IV-15). Since fallout is not always composed of the same isotopes in the same proportion, this chart is not an exact picture of what will be true in any particular situation. However, it represents the average situation and the actual is not likely to be very much different.

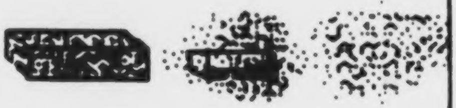
9. Another way to anticipate what the radiation decay will be is by use of the 7:10 Rule of Thumb which is that FOR EVERY SEVENFOLD INCREASE IN TIME AFTER DETONATION, THE RADIATION DOSE RATE DECREASES TENFOLD. (See Master #IV-16 & #IV-17).

10. For example, if the dose rate one hour after detonation is at its maximum amount, seven hours later it will be down to 10 percent of that amount. Thus, 90 percent of the radiation will have decayed in the first seven hours. Forty-nine hours or approximately two days after detonation, the dose rate will be only one percent of the intensity that it was in the beginning. At 7 x 49 hours or 343 hours, approximately two weeks after detonation the dose rate will be only .1 percent of the initial rate. As explained with the chart, this rule will not give the exact answer in every case but it will be close enough for practical purposes.

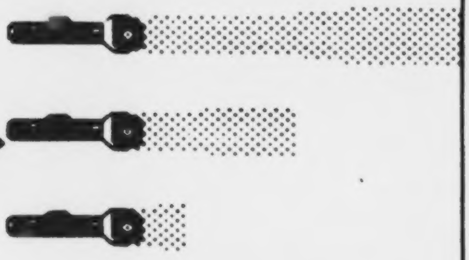
MASTER #IV-13

Time

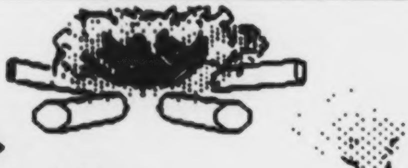
Ice Melts in Time.



Flashlight brilliance decreases in Time.



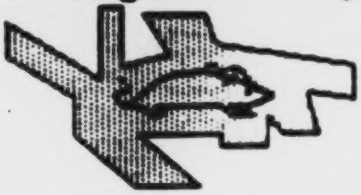
Fuel burns in Time.



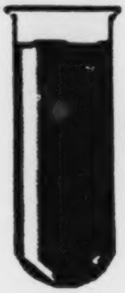
MASTER #IV-14

Decay.

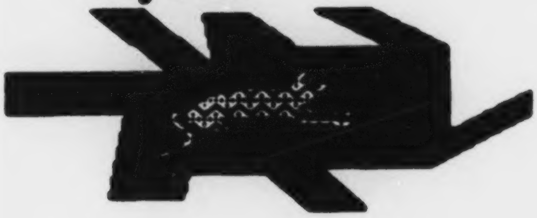
Mouse:
Average life = 2 years



Sodium 24:
Half-life =
15 hours

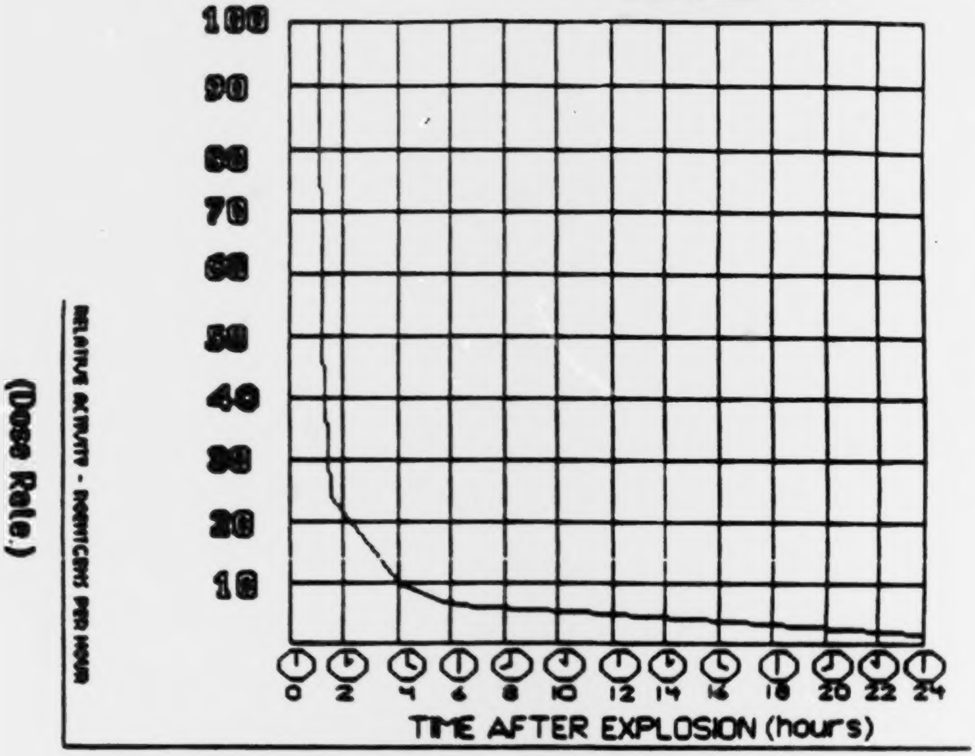


Cat
Average life =
10 years



Strontium 90
Half-life =
28 years

Rate of Fission Products Decay Chart.



Rate of Decay of Fission Products After Explosion.

Radioactive Decay.

Time Radiation

H + 1 hr. = 100 %

H + 7 hrs. = 10 %

H + 49 hrs. = 1 %

H +343 hrs. = .1 %

Subject: Radiation Intensity-Distance and Time Factors.

Class Exercise.

As the distance from the source is doubled, the intensity of radiation is divided by four.

EX. A	25 feet 320 r/hr.	50 feet 80 r/hr	100 feet 20 r/hr.	200 feet 5 r/hr
1.	10 feet	______	______	______
	160 r/hr.	______	______	______
2.	60 feet	______	______	______
	640 r/hr.	______	______	______
3.	1 foot	______	______	______
	1600 r/hr	______	______	______

As the number of hours (following arrival of fallout) is multiplied by seven, the intensity of radiation is divided by ten.

EX B.	H+1 hr.	3000 r/hr.	4. H+1 hr	6000 r/hr
	H+7 hr.	300 r/hr.	H+ ______ hrs.	______ r/hr.
	H+49 hrs. (2 days)	30 r/hr	H+ ______ hrs.	______ r/hr
	H+343 hrs. (2 weeks)	3 r/hr.	H+ ______ hrs.	______ r/hr
5.	H+3 hrs.	4000 r/hr.	6. H+ ______ hrs.	______ r/hr
	H+ ______ hrs.	______ r/hr	H+ ______ hrs	______ r/hr
	H+ ______ hrs.	______ r/hr	H+ ______ hrs.	______ r/hr

ACTIVITY #8D (PRINCIPLE OF DISTANCE)

(1) Prepare transparency of Master #IV-18.

(2) Explain the reduction in radiation intensity at the 100 ft., 200 ft., and 400 ft. distances.

(3) Using student handout on radiation intensity have students calculate radiation levels in examples #1, #2, #3.

(4) Demonstrate radiation intensity by standing in front of a filmstrip projector so no light appears on screen in front of room. Slowly move away and have students observe your shadow appearing on screen. Point out that the further you move away, the more light misses you and reaches the screen. Radiation intensity decreases the same way the further you can get from it.

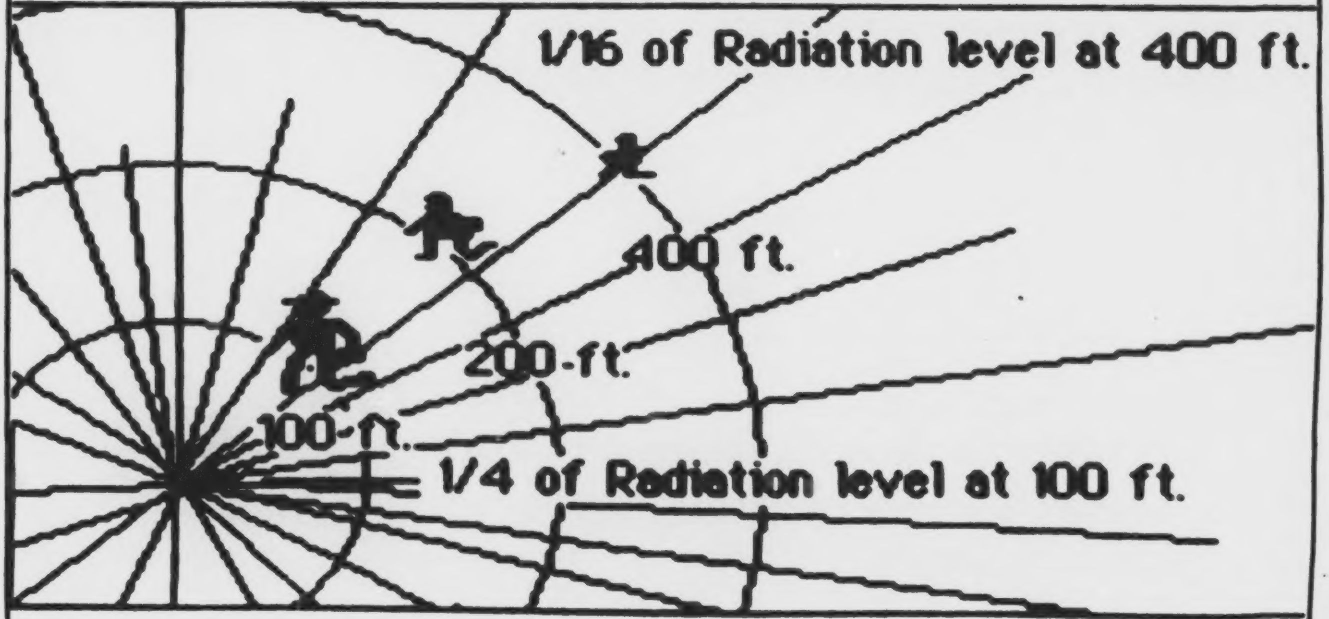
BACKGROUND INFORMATION

RADIATION DECREASES WITH DISTANCE

1. As the distance from the source of radioactivity increases, the radiation intensity decreases rapidly. Actually, the level is reduced as the square of the distance from the radiation source (See Master #IV-18). In other words as the distance from the source is doubled the intensity of radiation is divided by four (See Master #IV-17).

2. The harmful effects of the radiation can be greatly reduced if individuals keep as far away as possible from areas where radioactive fallout debris can collect; for example, by going to an intermediate floor of a tall building. If it is impossible to get away from areas where fallout material can collect, then try to clear the fallout from the area by washing down with water.

Effect of Distance on Radiation Intensity.


1/16 of Radiation level at 400 ft.
400 ft.
200 ft.
100 ft.
1/4 of Radiation level at 100 ft.

ACTIVITY #8E (PRINCIPLE OF SHIELDING)

(1) Prepare transparencies of Masters #IV-19A-B, #IV-20.

(2) Using Masters #IV-19A-B have students determine which materials would provide the greatest shielding from radiation and which material the least shielding.

(3) Demonstrate the principle of shielding from radiation using a scintillation counter if your physics department has one.

(4) Using Master #IV-20 have students calculate shelter protection factors. Provide the students with various levels of radiation inside and outside shelter and calculate protection factors.

BACKGROUND INFORMATION

SHIELDING PROVIDES PROTECTION FROM RADIATION

1. Another means of achieving protection from radiation is to place a barrier or shield between the source of radiation and the individual. The better the shield or barrier between an individual and a source of radiation the more protection an individual is afforded. A fallout shelter is a shield against radiation. It provides the most practical means of protecting people from external gamma exposure.

2. Barrier shielding is effective because some of the gamma rays are absorbed in their passage through the shield; thus, fewer rays emerge than enter. As the atoms which make up the shield material are packed more closely together, more of the entering gamma rays experience absorption by collision with one of these atoms. The denser the array of atoms, the greater the amount of gamma radiation that is absorbed; or, the denser the material, the more protection it affords.

3. The effectiveness of a given substance in decreasing the intensity of radiation is sometimes expressed by means of a quantity called the "half value layer thickness." This is defined as a layer of shielding required to reduce the intensity of gamma radiation one half. Although radiation is reduced by barriers, no matter how many half thicknesses we have, some radiation will always get through (See Master #19A)

4. Half value layer thicknesses will differ depending on the material used. (See Master #IV-19B). The more dense the material, the thinner the half value layer required for the same amount of protection. Most of us are aware of the fact that lead offers excellent protection from radiation, however, such protection is very expensive. There are other more common and much less expensive materials which will afford the same protection. However, a larger amount of other material will be required to make up one half thickness. Some comparative thickness of materials which offer about the same degree of shielding are:

   (1) Lead - 1 3/4 inches
   (2) Steel - 4 3/4 inches
   (3) Concrete - 16 inches
   (4) Earth - 24 inches
   (5) Water - 40 inches
   (6) Wood - 65 inches

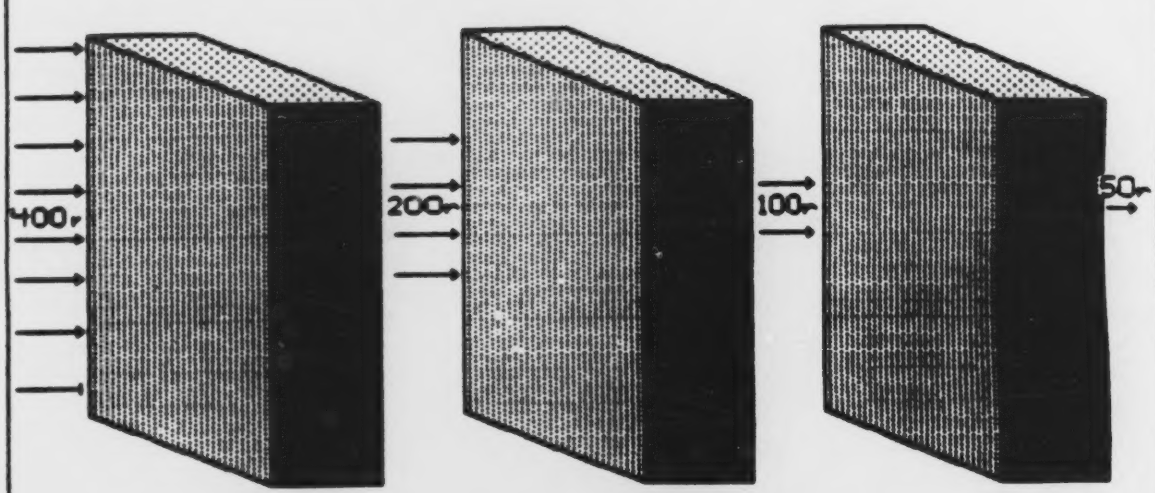
   In the case of barrier shielding, it is a matter of how much weight of any material you can get between you and the radioactive source. One 100 pounds of paper will be just as effective as 100 pounds of lead, concrete, earth, or any other material.

5. Shelter Protection Factor

   (a) The effectiveness of the protection provided by shielding and distance is measured by the shelter protection factor. This may be defined as the relation between the exposure of an unprotected person compared to his exposure if he were in a shelter. (See Master #IV-20).

   (b) For example, an unprotected person would be exposed to 125 times more radiation than a person inside a shelter with a protection factor of 125.

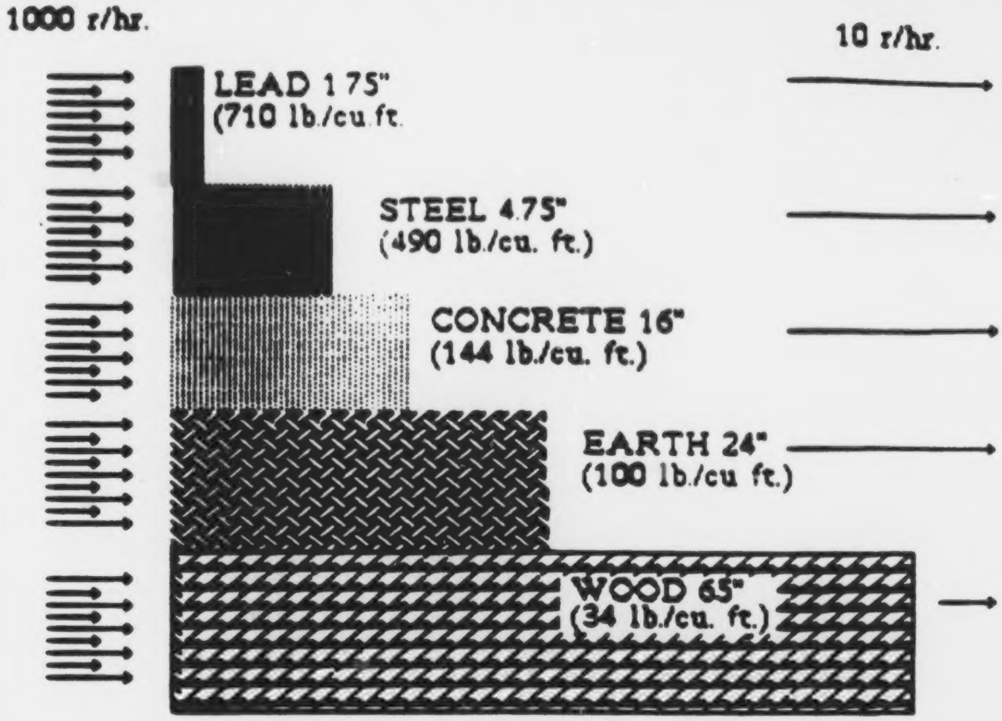
Shielding by Half-Value Layers


400r
200r
100r
50r

A Half-Value Layer of Shielding is That Amount Which Will Reduce Gamma Radiation By One-Half.

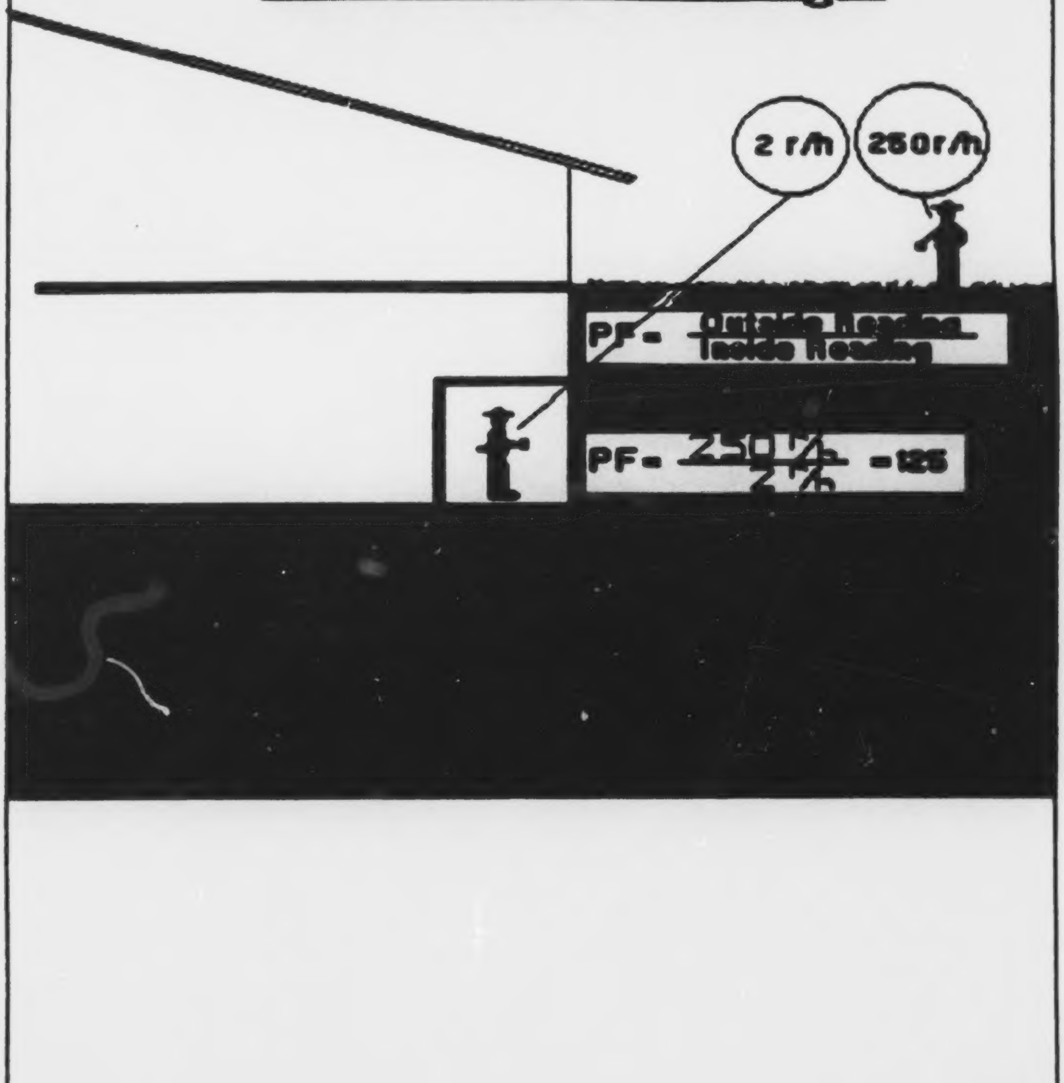
MASTER 8IV-19 B

Material Thickness for Protection Factor of 100


1000 r/hr.
10 r/hr.
LEAD 1.75"
(710 lb./cu.ft.
STEEL 4.75"
(490 lb./cu. ft.)
CONCRETE 16"
(144 lb./cu. ft.)
EARTH 24"
(100 lb./cu ft.)
WOOD 65"
(34 lb./cu. ft.)

MASTER #IV-20

Outside Rad. Readings Vs. Inside Rad. Readings.



$$PF = \frac{\text{Outside Reading}}{\text{Inside Reading}}$$

$$PF = \frac{250\ r/h}{2\ r/h} = 125$$

ACTIVITY #9

TITLE: MODERN WEAPONS AND RADIOACTIVE
+ FALLOUT (EFFECTS)

PURPOSE: To compare conventional and nuclear weapons and examine their destructive effects.

OBJECTIVE:
(1) Students should be able to explain the blast, thermal and radiation effects of nuclear weapons.
(2) Students should be able to construct examples of nuclear zones of destruction.
(3) Students should be able to compare destructive effects of various size nuclear weapons.

MATERIALS: Masters #IV-21 thru #IV-26

PROCEDURE:

ACTIVITY #9A (CONVENTIONAL VS NUCLEAR WEAPONS)

(1) Prepare transparency of Master #IV-21.

(2) Have students prepare a chart comparing conventional to nuclear weapons.

(3) Have students list on chart fuel source and destructive forces of conventional and nuclear weapons.

(4) Have students write a summary describing the major differences between conventional and nuclear weapons.

BACKGROUND INFORMATION

INTRODUCTION

Both the military forces and the civilian population of the United States may be endangered by the effects of modern weapons. The purpose of this lesson is to explain the basic effects of nuclear weapons. An understanding of thermal radiation, blast, and nuclear radiation is necessary before proper protective actions can be developed against them.

COMPARISON OF CONVENTIONAL AND NUCLEAR WEAPONS

1. Conventional weapons are those which depend on TNT or similar non-nuclear explosives. When a conventional high-explosive weapon is detonated, the sudden release of energy causes a considerable increase in temperature and pressure. Explosive materials are converted into hot, compressed gases. Since these gases are at very high temperature and pressures, they expand rapidly and, thus, initiate a pressure wave, called a blast wave, in the surrounding air, water, or earth. It is this blast wave that causes most of the damage.

2. Nuclear weapons are similar to those of conventional types insofar as there is destructive action due to blast.

3. There are several basic differences between nuclear and high-explosive weapons. (See Master #IV-21).

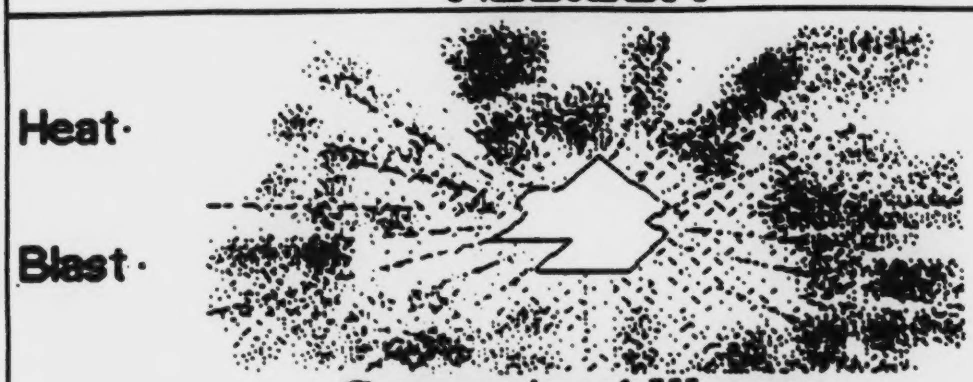
    (a) First, nuclear explosions can be many thousands (or millions) of times more powerful than the largest conventional detonations.

    (b) Second, the amount of heat emitted as thermal radiation is vastly greater than in conventional weapons and affects larger areas. Even at considerable distances it is capable of causing skin burns and of starting fires.

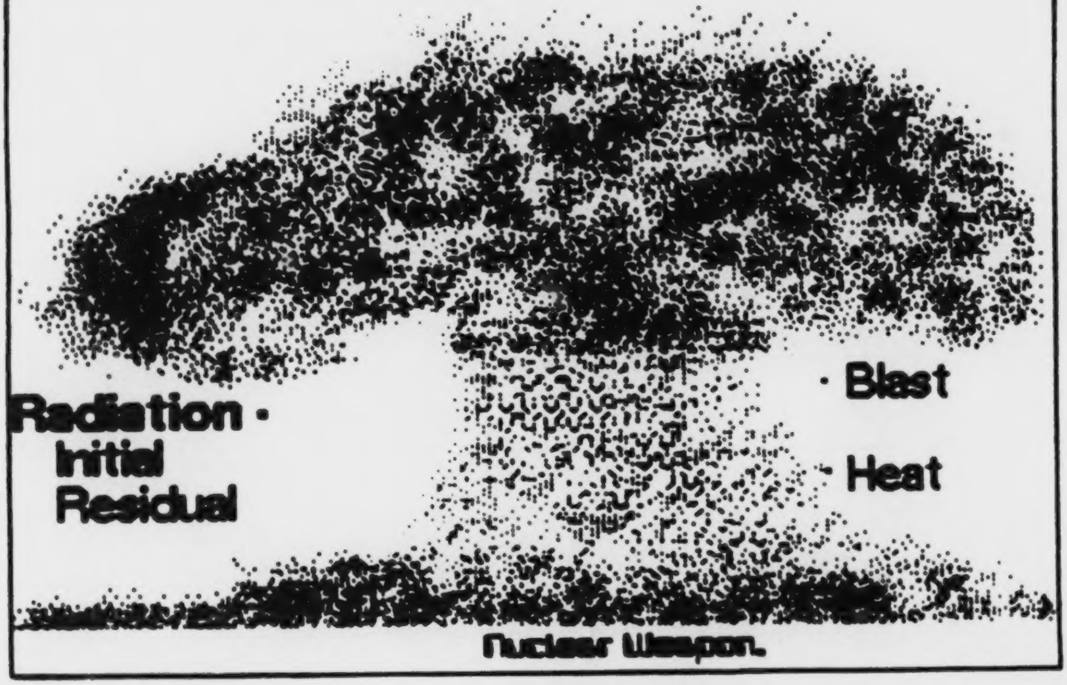
    (c) Finally, the nuclear detonation, unlike conventional explosions, results in the formation of radioactive particles. Some of these particles emit highly penetrating rays which are capable of inflicting widespread and serious bodily damage over an extended period of time.

MASTER $IV-21

Weapons
Conventional
vs.
Nuclear.



Conventional Weapon.


Radiation
Initial
Residual
Blast
Heat

Nuclear Weapon.

ACTIVITY #9B (DESTRUCTIVE CAPABILITIES)

(1) List on board the data comparing damage from WWII bombing of Hamburg to that of Hiroshima.

(2) Define the meaning of TNT, KT, and MT.

BACKGROUND INFORMATION

DESTRUCTIVE CAPABILITIES

1. Nuclear weapons have much greater destructive capability than conventional weapons.

2. The weapon used in the Hiroshima raid was small when compared to the thermo-nuclear weapons of today. However, it may be used to illustrate the tremendous destructive power of a nuclear weapon.

HAMBURG, GERMANY	HIROSHIMA, JAPAN
8 days bombing	1 plane
8800 tons HE and incendiaries	1 bomb - @15KT
6400 acres burned and blasted	1 city
60,000 killed	70,000 killed

NOTE: Explain the explosive power of a nuclear explosion as measured in terms of equivalent tons of TNT.

1 KT (kiloton) = 1,000 tons of TNT
1 MT (megaton) = 1,000,000 tons of TNT

3. It is diffucult to perceive the magnitude of the energy released in the detonation of a thermo-nuclear weapon. To illustrate this, assume that 100 bombers carry 10 tons each of high explosives over a target each day. It would require 55 years to deliver the equivalent of a 20 megaton nuclear weapon.

4. The energy resulting from the fission of one pound of uranium equals as much as the combustion of 1,400 tons of coal, 250,000 gallons of gasoline or 40,000 cubic feet of natural gas.

ACTIVITY #9C (ENERGY DISTRIBUTION)

(1) Prepare transparency of Master #IV-22.

(2) Prepare student copies of Master #IV-22 with information omitted.

(3) Have students fill in information on energy distribution.

(4) Have students write meaning of each form of radiation in their notebooks.

BACKGROUND INFORMATION

ENERGY DISTRIBUTION

(See Master #IV-22)

1. About 50% of the total energy from a typical nuclear air burst detonated near the earth appears as blast waves on ground shock.

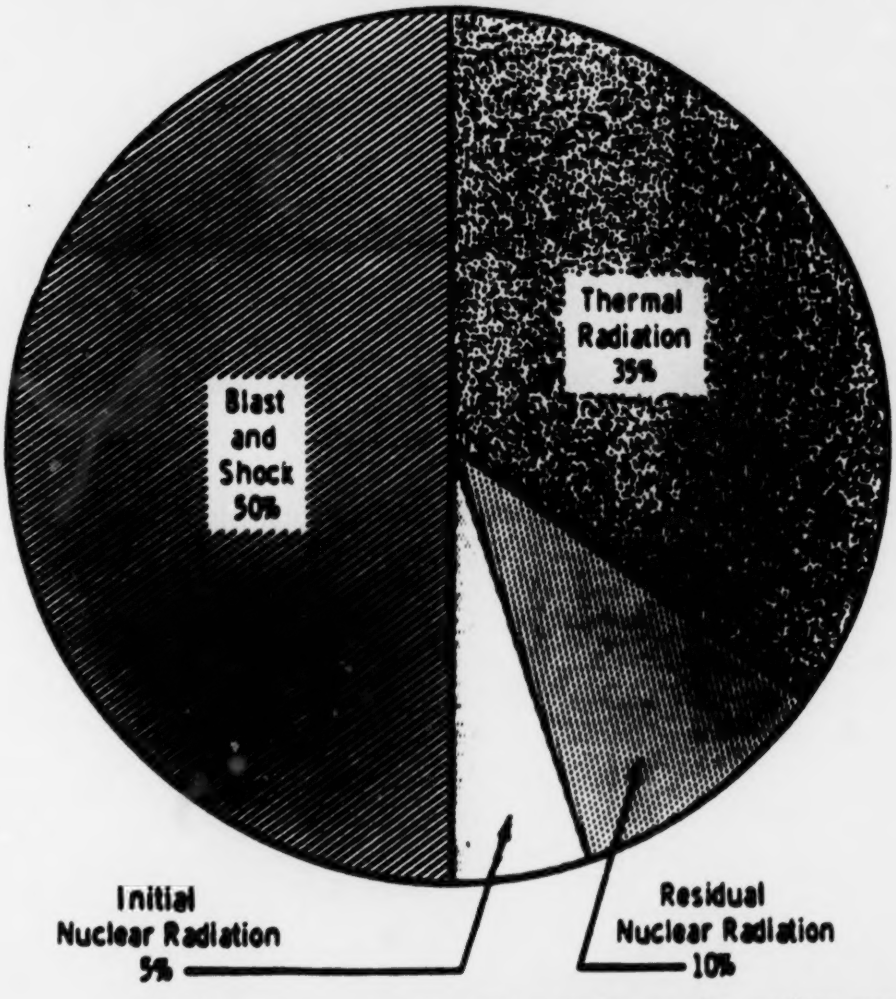
2. Thermal radiation accounts for about 35% of the total energy. This presents itself in the form of light and heat.

3. About 5% of the energy appears as initial nuclear radiation. This is the gamma radiation and neutrons that are emitted within the first minute after detonation.

4. Residual nuclear radiation accounts for the remaining 10% of the energy.

   This 10% consists of the nuclear radiation that is emitted from radioactive materials remaining after the first minute from the time of detonation. Although this represents only a small percentage of the total energy, it is highly significant. It poses a threat over large areas for an extended period of time. Yet, it is a hazard against which protection can be provided.

EFFECTS OF NUCLEAR WEAPON



—Distribution of energy in typical air burst of a nuclear weapon at an altitude below 100,000 feet.

ACTIVITY #9D (EFFECTS OF EXPLOSION)

A. Explosive Force

(1) Prepare transparency of Master #IV-23 and read background information.

(2) Have students answer the following guide questions:

(a) What is the diameter (radius given on diagram) of the crater?

(b) What is the diameter of the fireball?

(c) What is the diameter of A,B,C, D zones of destruction?

(d) Which zone would have the greatest damage and highest number of fatalities?

(e) How far from ground zero would you be safe from initial blast, heat and radiation.
NOTE: Fallout not considered.

BACKGROUND INFORMATION

EFFECTS OF THE EXPLOSION

The effects of the explosion and extent of damage will be determined primarily by the size of the weapon and type of burst. (See Master #IV-23).

1. The point directly beneath the center of a nuclear explosion is called ground zero.
2. The surrounding land, objects, and persons would suffer varying degrees of damage depending on their distance from ground zero and the size of the weapon.

3. From a 5 megaton surface burst the following ranges of damage may be expected.

   a. A circular area surrounding ground zero with a radius of approximately 3 miles where there would be almost complete destruction. (A-Zone)

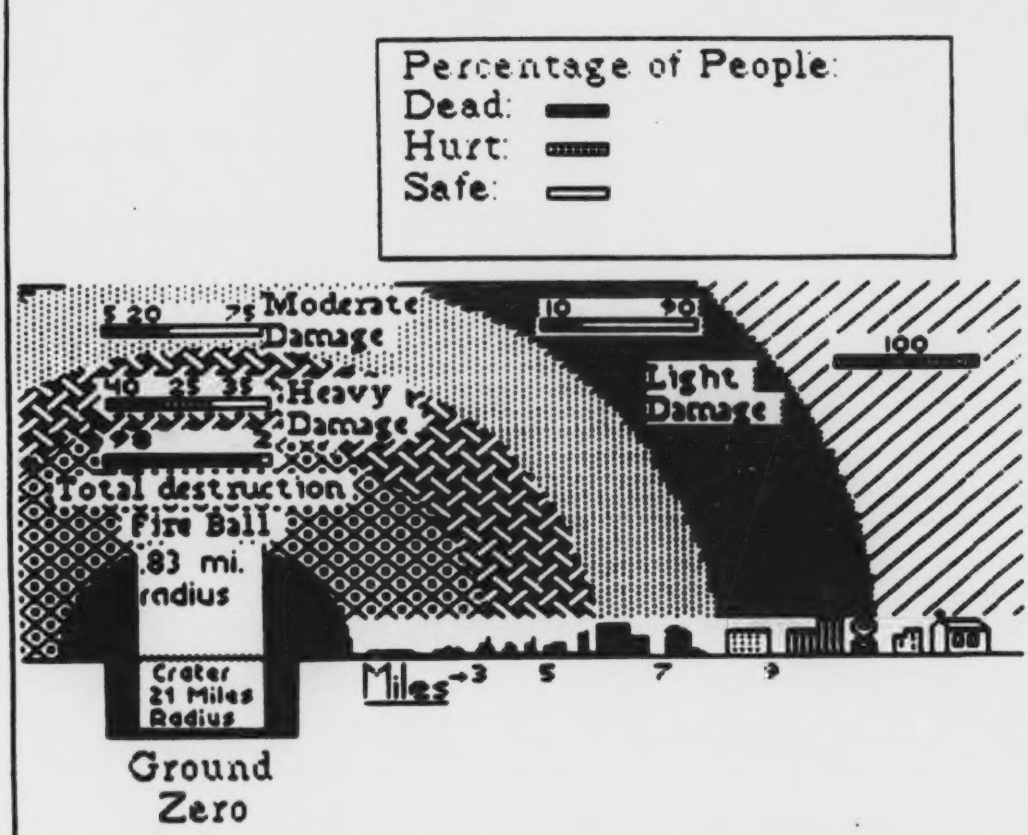
   b. From three to five miles from ground zero there would be heavy damage. Buildings in these areas would be damaged beyond repair by blast and fire. (B-Zone)

   c. Between five and seven miles from the point of detonation buildings would be moderately damaged. Most would be repairable. (C-Zone)

   d. An area sustaining light damage would extend from about seven to nine miles from ground zero. In this area most buildings would remain intact. However, fires, flying glass and other debris would be a problem. (D-Zone)

4. Blast Effects - A fraction of a second after a nuclear weapon explosion, the expanding gases would cause the development of a high pressure wave which would move outward from the fireball at about the speed of sound (1/5 of a mile per second). In doing so they produce destructive (blast or shock) effects of the explosion. The term blast effect is generally used for effects in air because they resemble a very strong wind.

122


Percentage of People:
Dead: ▬
Hurt: ▤
Safe: ▭
5 20 75 Moderate Damage
40 25 35 Heavy Damage
98 2
Total destruction
Fire Ball
.83 mi.
radius
Crater
21 Miles
Radius
Ground
Zero
10 90
Light Damage
100
Miles→3
5
7
9

Effects of a 5- Megaton Bomb.

B. Thermal Effects

(1) Prepare transparency of Master #IV-24 and read background information.

(2) Have students answer the following guide questions:

(a) What are the three types of skin burns?

(b) What damage does each cause to skin?

(c) How fast does thermal radiation travel?

BACKGROUND INFORMATION

THERMAL EFFECTS

1. Thermal radiation travels with the speed of light--186,000 miles per second. Hence, it reaches all points around the blast area much earlier than does the blast wave itself. In some ways thermal radiation resembles heat and light coming from the sun.

2. The thermal effects of a nuclear weapon can produce burns and set fires in areas beyond those affected by blast and shock.

3. From a 5 megaton ground burst the following effects on the exposed skin might be expected. (See Master #IV-24).

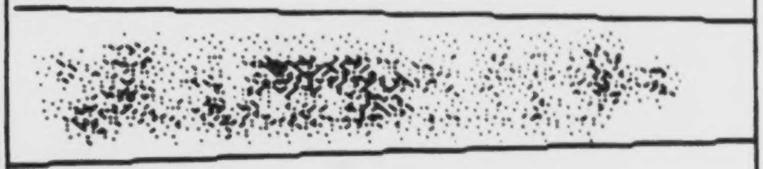
   a. First degree burns - 11 to 16 miles
   b. Second degree burns - 1- to 11 1/2 miles
   c. Third degree burns - up to 10 miles

MASTER #IV-24

Burns on Exposed Bare Skin

(5 MT Ground Burst)

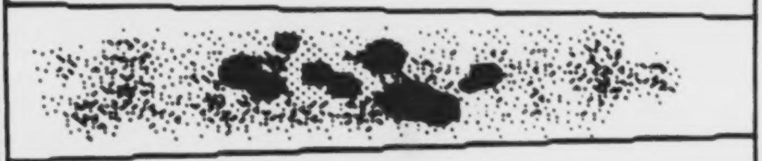
11 to 16 Miles from zero.



First Degree - Skin Redness.

A

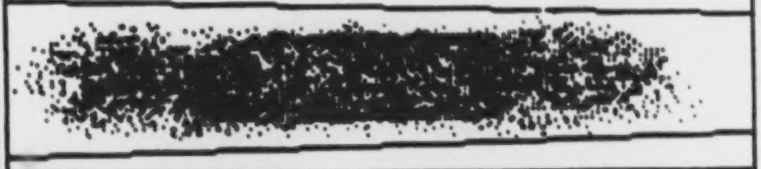
10 to 11 1/2 Miles From Zero.



Second Degree - Blisters Develop.

B

Zero to 10 miles.



Third Degree - Tissue is Destroyed.

C

C. Nuclear Radiation

(1) Prepare transparency of Master #IV-25 and read background information.

(2) Have students answer the following guide questions:

(a) What is meant by the term initial radiation?

(b) What is the composition of initial radiation?

(c) Whch area would cause the most severe burns?

BACKGROUND INFORMATION

NUCLEAR RADIATION

Nuclear radiation is emitted as either initial or residual. (See Master #IV-25).

1. Initial radiation is radiation emitted during the first minute after a nuclear detonation. It consists of gamma rays and neutrons. Because the area of severe damage from blast and fire effects extends to a far greater distance from ground zero than the area in which initial radiation can cause casualties, initial radiation does not present an additional survival problem.

2. While blast, fire, and initial radiation would cause widespread destruction, radioactive fallout could affect a much greater geographical area and threaten additional millions of people.

[illegible]

Consists of:

- Gamma Radiation
- Neutrons

Occurs: During first minute after detonation.

Effective: Only in the most severe blast area.

Therefore: Is not major concern to survival.

D. Fallout Information

(1) Prepare transparency of Master #IV-26 and read background information.

(2) Have students answer the following guide questions:

   (a) What is fallout?

   (b) How is fallout produced?

   (c) What is the size of fallout particles?

   (d) What determines the rate that fallout returns to the earth?

   (e) How far can fallout particles extend from ground zero?

BACKGROUND INFORMATION

FALLOUT FORMATION

1. When a nuclear explosion occurs close to the ground, particles of earth and debris amounting to thousands of tons of material are taken up into the fireball and rise in the mushroom cloud. These particles become fused or vaporized because of the extremely high temperature in the fireball. Later they become incorporated with the fission products and radioactive residues of the weapon. The particles gradually fall back on the earth as sources of radioactivity called FALLOUT. (See Master #IV-26).

2. Radioactive debris - fallout - may be of many sizes. Particles the size of sand may be carried many miles from the point of explosion. Most fallout particles are visible but the nuclear radiation given off by them cannot be detected by the senses directly. Radiation cannot be seen, heard, smelled, felt, or tasted.

3. It takes time for fallout to drop from a nuclear cloud. The size of the particles is an important factor in determining the rate of their return to earth.

   a. Large particles fall faster, land closer and are more radioactive.

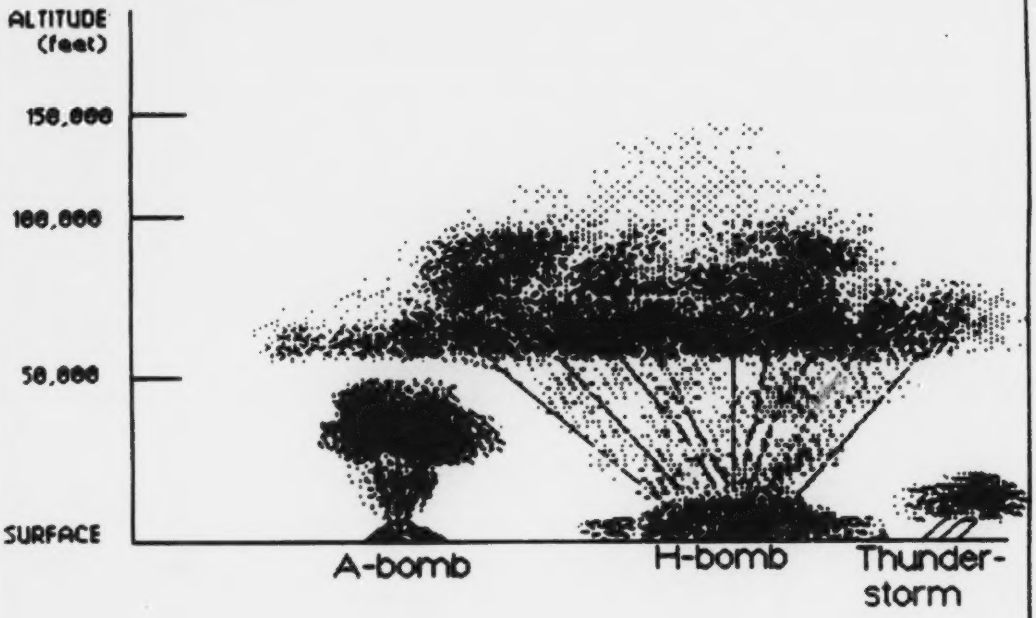
   b. Small particles fall more slowly and land farther away.

   c. Fallout distribution is determined primarily by high altitude winds that often blow in quite a different direction from ground winds.

   d. The height of the cloud will also influence where particles fall.

   e. The area of severe fallout might stretch 5 miles or more upwind of ground zero and 150 - 200 miles downwind depending on the strength of the wind and the bomb yield.

Nuclear Fallout:



Comparative size of A-bomb mushroom, H-bomb mushoom, and Thunderstorm cloud.

ACTIVITY #10

TITLE: NUCLEAR MAPPING

PURPOSE: To demonstrate the effect of nuclear war on your life and the state in which you live.

OBJECTIVE:

(1) Students should be able to visually understand the effect of nuclear war.

(2) Students should be able to understand the current magnitude of global destructive power.

(3) Students should be able to state the reason and need for nuclear disarmament.

MATERIALS:

(1) New Jersey road maps (one per two students

(2) Compasses

(3) Rulers

(4) String

(5) Crayons or colored pencils

(6) 4 x 6 index cards

(7) Diagram of nuclear damage zones (See Master #IV-27)

(8) Damage zone radii for various size nuclear weapons (See Master #IV-28)

(9) Chart on general effects of a 20 megaton nuclear bomb (See Master #IV-29)

(10) Chart on blast effects of a nuclear weapon (See Master #30)

PROCEDURE:

(1) Divide students into pairs .

(2) Distribute copies of Master #IV-27 and #IV-28.

(3) Assign each pair of students a nuclear weapon in KT or MT range.

(4) Explain the four zones of destruction and the color code for each using Master #IV-27.

(5) Have students select key target, areas or strategic installations that would most likely be attacked.

(6) Place an "X" at these locations.

(7) Using a compass, locate map scale and open compass to radius for "A" zone of the weapon assigned.

(8) Place compass point at each "X" mark and draw circle representing the "A" zone.

(9) Repeat same process for "B", "C", and "D" zones (always place compass point at the "X" mark).

(10) Students with larger weapons may have to use string as compass may not open far enough.

(11) Have students color each zone as indicated on chart.

(12) Mount best example of each size weapon on wall in sequence.

(13) Hand out copies of Master #IV-29 and discuss the effects of each of the various size weapons.

(14) Hand out copies of Master #30 and discuss the blast effects of a nuclear weapon.

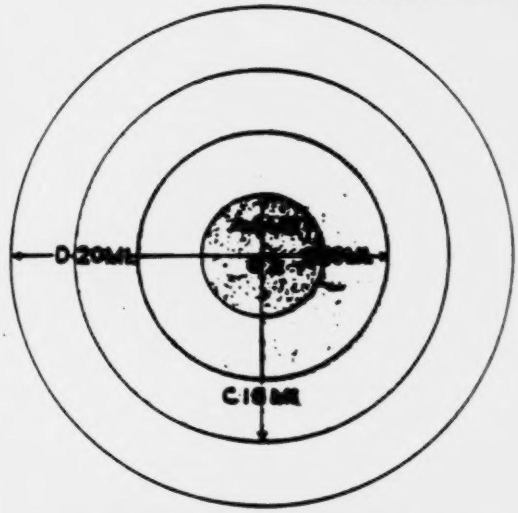
(14) NOTE: Point out to students that the bomb dropped on Hiroshima was 915K and the total range of destruction was less than the "A" zone of the 100KT weapon.

(15) Have students report on articles dealing with the topic nuclear winter.

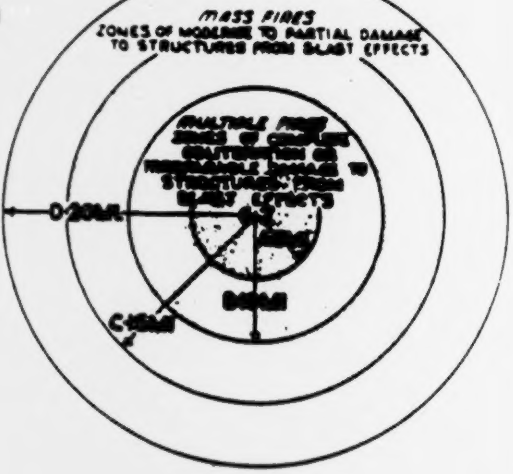
(16) Have a class discussion on students' views of nuclear weapons and the outcome of a nuclear war.

MASTER #IV-27

Radii of Destruction:


D-20MI
C-16MI

Estimated extent of A,B,C, and D zones of damage that would result from surface detonation of a 20-MT (Megaton) Nuclear weapon.


MASS FIRES
ZONES OF MODERATE TO PARTIAL DAMAGE TO STRUCTURES FROM BLAST EFFECTS
MULTIPLE FIRES
STRUCTURES FROM BLAST EFFECTS
D-20MI
C-16MI

Extent of fire damage expected from surface detonation of 20-Mt (Megaton) nuclear weapon.

MASTER #IV-28

NUCLEAR ZONES OF DESTRUCTION

NUCLEAR WEAPON SIZE	ZONE "A" radii	ZONE "B" radii	ZONE "C" radii	ZONE "D" radii
100 KT	1.0 miles	2.0 miles	3.0 miles	4.0 miles
500 KT	1.5 miles	3.0 miles	4.5 miles	6.0 miles
1 MT	2.0 miles	4.0 miles	5.5 miles	7.5 miles
5 MT	3.0 miles	6.0 miles	9.0 miles	12.0 miles
10 MT	4.0 miles	7.5 miles	11.5 miles	15.0 miles
20 MT	5.0 miles	10.0 miles	15.0 miles	20.0 miles
50 MT	12.0 miles	25.0 miles	37.0 miles	50.0 miles
100 MT	24.0 miles	50.0 miles	74.0 miles	100.0 miles

ZONE COLOR--"A"=Red "B"=Orange "C"=Green "D"=Blue

GENERAL EFFECTS OF A 20-MEGATON NUCLEAR BOMB.

TYPE OF DAMAGE			SURFACE BURST	AIR BURST
BLAST AND SHOCK DAMAGE	Crater diameter (dry soil)		3500 ft.	0 ft.
	Crater depth (dry soil)		350 ft.	0 ft.
	Zone A-Area of almost complete physical destruction.		4 mi. rad.	5 mi. rad.
	Zone B-Area of heavy physical Damage.		8 mi. rad.	10 mi. rad.
	Zone C-Area of light to moderate damage.		12 mi. rad.	15 mi. rad.
	Zone D-Area of light to partial damage.		16 mi. rad.	20 mi. rad.
THERMAL RADIATION DAMAGE	**BURNS** To exposed flesh for an exposure duration of approx. 1 minute	3rd degree	16 mi. rad.	28 mi. rad.
		2nd degree	20 mi rad.	33 mi. rad.
		1st degree	28 mi. rad.	45 mi. rad.
	FIRES Mass fires which will destroy groups of blocks or buildings.		10 mi. rad.	14 mi. rad.
	Scattered fires.		20 mi. rad.	38 mi. rad.
INITIAL NUCLEAR RADIATION DAMAGE	Medial lethal dose of Gamma radiation (no shielding, exposure of about 1 min.) 450 roentgens.		2.5 mi. rad.	3.7 mi. rad.
RESIDUAL NUCLEAR RADIATION (Fallout)	Approx. fallout pattern bands. These will be oval shaped. They will depend upon the wind directions and other meteorological conditions at the time of burst. These estimates are for a ground burst only and assume that the fallout is complete 1 hr. after the burst and that wind conditions are the same at various altitudes as the average conditon in the Philadelphia region.		Dose Rate	Band Width
			3000 r/hr_1	6.2 mi.
			1000 r/hr_1	14 mi.
			300 r/hr_1	24 mi.
			100 r/hr_1	38 mi.
			30 r/hr_1	57 mi.
			10 r/hr_1	88 mi.

Blast Damage by a Nuclear Bomb.

ITEM	ZONE A OF DAMAGE	ZONE OF B DAMAGE
Ordinary buildings (typical urban complex)	Virtually completely destroyed.	Severely damaged or destroyed; buildings must be torn down.
Reinforced concrete or steel-frame buildings.	Buildings standing but most masonry panel walls and non-load bearing partitions destroyed or displaced.	Buildings standing but many masonry walls and non-load bearing partitions destroyed or displaced.
Highways and streets.	Impassable.	Impassable.
Elevated roads and short span bridges.	Some destroyed; approaches blocked; decks of steel plate bridges may shift laterally.	Some severely damaged; bridge approaches blocked by rubble and disabled vehicles.
Vehicles: autos, busses, trolleys, trucks.	Vehicles unusable.	Vehicles generally unusable.
Water mains.	Some mains broken especially at ground zero and on bridges.	Not damaged except on bridges.
Water pipes in buildings.	Numerous breaks causing loss in pressure.	Numerous breaks causing loss in pressure.
Elevated water tanks and towers.	Mostly destroyed or damaged beyond use.	Mostly destroyed or damaged beyond use.
Sewers and storm drains.	Some mains broken.	Not damaged.
Gas mains.	Some mains broken,. especially at ground zero.	Not damaged except on bridges.
Gas pipes in buildings.	Numerous breaks.	Numerous breaks.
Overhead electric power lines, poles, and transformers.	Destroyed.	Destroyed or severely damaged.
Radio & T.V. towers.	Destroyed.	Some destroyed.
Above ground oil tanks.	Destroyed.	Probably destroyed.

Blast Damage by a Nuclear Bomb. (cont.)

ITEM	ZONE C OF DAMAGE	ZONE D OF DAMAGE
Ordinary buildings (typical urban complex)	Moderately or severely damaged; moderately damaged buildings must be vacated for repairs.	Partially damaged; buildings need not not be vacated for repairs.
Reinforced concrete or steel-frame buildings.	Interiors moderatly damaged.	Interior slightly damaged.
Highways and streets.	Require clearing before use.	Probably usable.
Elevated roads and short span bridges.	Moderately damaged; approaches blocked; generally usable.	Probably damaged but usable.
Vehicles: autos, busses, trolleys, trucks.	Some vehicles unusable.	Most vehicles usable.
Water mains.	Not damaged.	Not damaged.
Water pipes in buildings.	No breaks causing loss in pressure.	No breaks.
Elevated water tanks and towers.	Tanks supported by frames may fall.	Partially damaged; probably usable.
Sewers and storm drains.	Not damaged.	Not damaged.
Gas mains.	Not demaged.	Not damaged.
Gas pipes in buildings.	A few breaks.	Probably no breaks.
Overhead electric power lines, poles, and transformers.	Poles mostly unusable, wires broken by falling or flying objects.	Poles mostly intact, wires broken by falling or flying objects.
Radio & T.V. towers.	Some destroyed.	Partly damaged; may be used.
Above ground oil tanks.	Possibly destroyed.	Not damaged.

Unit V

Astronomy.

ACTIVITY #1

TITLE: GALAXIES-BUILDING BLOCKS OF UNIVERSE

PURPOSE

To describe the different types of galaxies.

OBJECTIVE

Students should be able to identify and diagram different types of galaxies.

MATERIALS

Show film, filmstrip or slides depiciting the various types of galaxies.
(See Curriculum Guide pp.37-38)

PROCEDURE:

(1) Show photographs of various types of galaxies.

(2) Have students name, diagram and discuss the composition of the different types of galaxies.

(3) Have students diagram the Milky Way and locate the relative position of our solar system.

ACTIVITY #2

TITLE: STAR CONSTELLATIONS

PURPOSE

Students should be able to locate and identify star constellations using star charts of the Northern Hemisphere.

MATERIALS

Slides or filmstrip of Northern Hemisphere stars (See Curr. Guide pp.37-38) & Master #V-1

PROCEDURE

(1) Show slides or transparency of star chart depicting the circumpolar stars of the Northern Hemisphere (Use Master #V-1)

(2) Have students name and diagram circumpolar star constellations.

(3) Distribute a star chart to each student and demonstrate how to correctly position chart for locating stars for each season of the year.

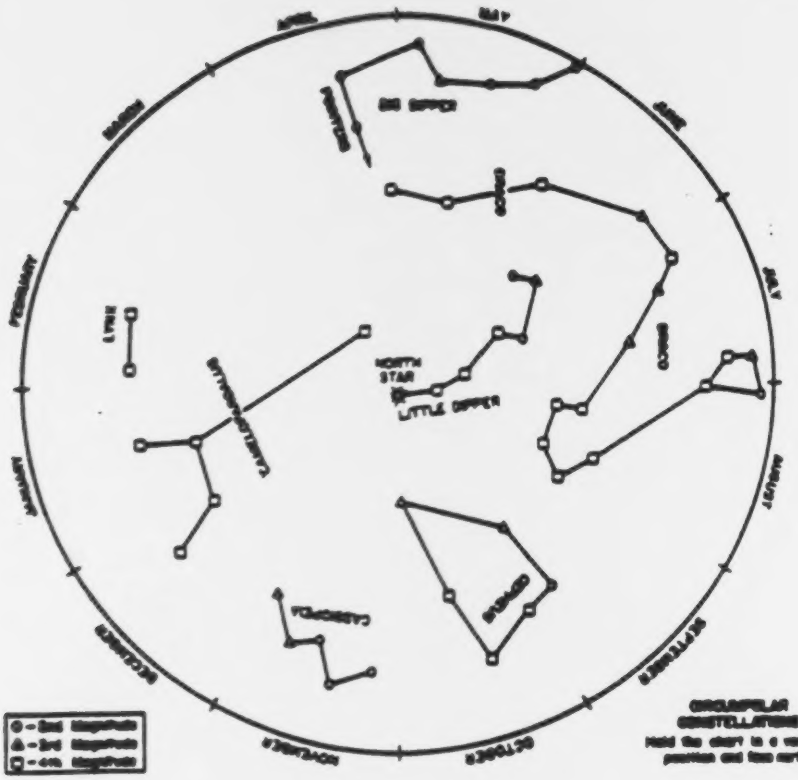
(4) Finding the Big Dipper (the familiar part of Ursa Major, the Big Bear) is the most basic exercise the student can do. It will help to locate the north and aid in determining approximate elevation. Other constellations and stars can be located if the Big Dipper is used as a reference point.

(5) Have students locate other stars and star constellations in east, south and west for your longitude, latitude and season of the year the study is being conducted.

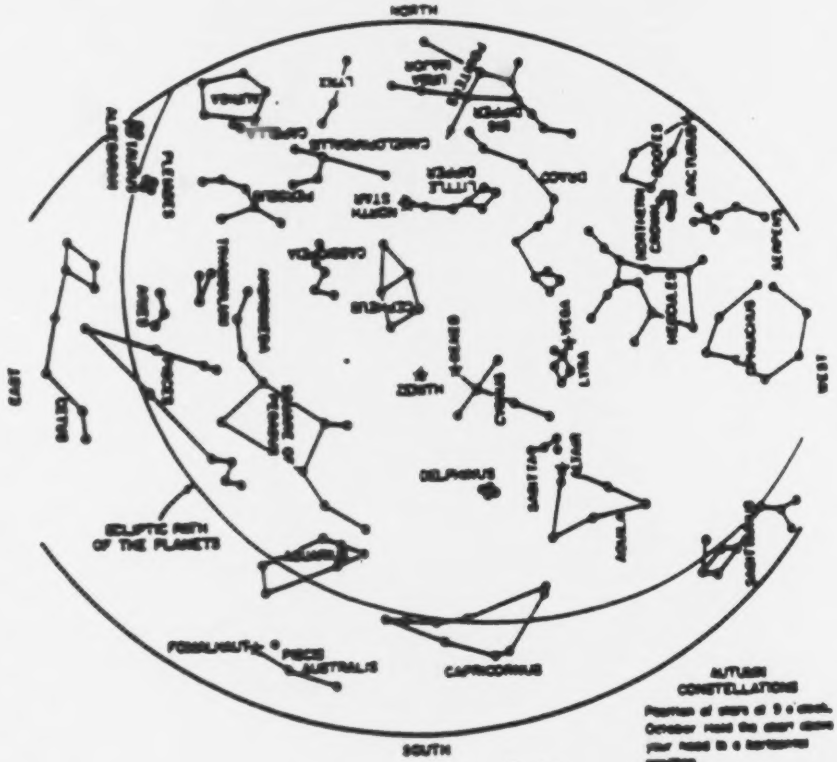
(6) Describe to the students the meaning of star magnitude and the various star colors that will be observed.

(7) Plan a night astronomy class for the Autumn, Winter and early Spring to show how star patterns change seasonally.

(8) Prepare a lesson with the star chart for each season to help students in star location whether as a class activity or on their own.


APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
BIG DIPPER
POINTERS
DRACO
LYNX
CAMELOPARDALIS
NORTH STAR
LITTLE DIPPER
CASSIOPEIA
CEPHEUS
● - 2nd Magnitude
▲ - 3rd Magnitude
□ - 4th Magnitude

CIRCUMPOLAR
CONSTELLATIONS
Hold the chart in a vertical
position and face north.


NORTH
LYNX
URSA MAJOR
BIG DIPPER
CAPELLA
CAMELOPARDALIS
PLEIADES
ALDEBARAN
PERSEUS
LITTLE DIPPER
NORTH STAR
DRACO
ARCTURUS
NORTHERN CROWN
BOOTES
HERCULES
SERPENS
CASSIOPEIA
CEPHEUS
ANDROMEDA
TRIANGULUM
PEGASUS
ARIES
PISCES
CETUS
EAST
ZENITH
VEGA
LYRA
CYGNUS
DENEB
DELPHINUS
SAGITTA
AQUILA
OPHIUCHUS
WEST
ECLIPTIC PATH
OF THE PLANETS
AQUARIUS
FOMALHAUT
PISCES
AUSTRALIS
CAPRICORNUS
SAGITTARIUS
SOUTH

AUTUMN
CONSTELLATIONS
Position of stars at 9 o'clock,
October. Hold the chart above
your head in a horizontal
position.

ACTIVITY #3

TITLE: THE SOLAR SYSTEM

PURPOSE

To show how the members of the solar system differ from each other.

OBJECTIVE

Students should be able to name and describe the known characteristics of the planets in the solar system.

MATERIALS

Photos, film, or filmstrip showing the planets in the solar system.
(See Curriculum Guide pp. 37-38)

PROCEDURE

(1) Have students identify and diagram the planets in their orbits about the sun.

(2) Assign groups of two or three students to research the characteristics of one planet. The information should include the following.

- (a) Photos (most recent available)
- (b) Atmosphere
- (c) Temperature Range
- (d) Water
- (e) Gravity relative to earth
- (f) Diameter
- (g) Composition
- (h) Distance from the Sun

(3) Have each group present a class report on their findings.

(4) Record data on a large bulletin board display or on a chart in their notes.

(5) Have class discuss the possibilities of life on each planet.

ACTIVITY #4

TITLE: COMETS

PURPOSE

To examine the characteristics of comets.

OBJECTIVES

Students should be able to:

(1) Draw a comet and label its parts.

(2) Explain that light radiation exerts pressure.

(3) Place ultraviolet radiation in the electomagnetic spectrum correctly and compare its wavelength to that of light.

MATERIALS

Dry ice
Crushed ice
Flashlight
Vacuum cleaner
Ultraviolet light source

PROCEDURE

(1) Have students draw and label the parts of the Comet.

(2) Have students discuss why the tail is visible only when the Comet is close to the Sun. Use dry ice to represent the Comet, a flashlight to represent the Sun's light, and a vacuum cleaner's blower-end attatched to the flashlight to represent the solar pressure of the light. Darken the room. Have a student circle close to the "Sun"carrying the tray of dry ice while the blower directs the sublimating gas away from the coma. Observe that the gaseous tail is always streaming away from the Sun. Question students as to which parts of the demonstration are similar to Comet Halley's trip close to the Sun. Explain that the pressure of light is due to tiny particles called photons. Light can exist in fact as both wave and particles. The pressure of our Sun's light is called the solar wind in space.

(3) Exhibit a "dirty snowball" with a rock core. Explain that in the vacuum of space, ice changes to gas without melting (sublimation). The dirt becomes the dust of the tail, and the particles in the rocky core eventually disintegrate to dust. We see them as meteors in our upper atmosphere.

(4) Darken the room and demonstrate one property of ultraviolate light by shining and ultraviolet (UV) light source on "glow in the dark" materials. Clap erasers near the beams of UV source to see if eraser dust appears different under UV than in normal light. **WARNING:** Do not allow students to look directly at the bulb. The light could burn the eye's retina.

(5) Show where UV radiation is located on the electromagnetic spectrum chart. It has shorter wavelengths than visible light, but not as short as x-rays. Explain that astronomers have used space orbiting spectrometers sensitive to UV to study dust clouds, our Milky Way, and other galaxies.

ACTIVITY #5

TITLE: SOLAR ECLIPSE

PURPOSE

To learn mechanics of a solar eclipse.

OBJECTIVE

Students should be able to diagram and explain the cause of a solar eclipse.

MATERIALS

Master #V-2

Rulers

PROCEDURE

(1) Prepare a transparency of Master #V-2.

(2) Prepare student copies of Master #V-2 with the terms penumbra and umbra and all lines omitted.

(3) Have students draw lines from the outer edge of the Sun to the Earth forming the umbra.

(4) Have students draw lines from the outer edge of the Moon to the Earth forming the penumbra.

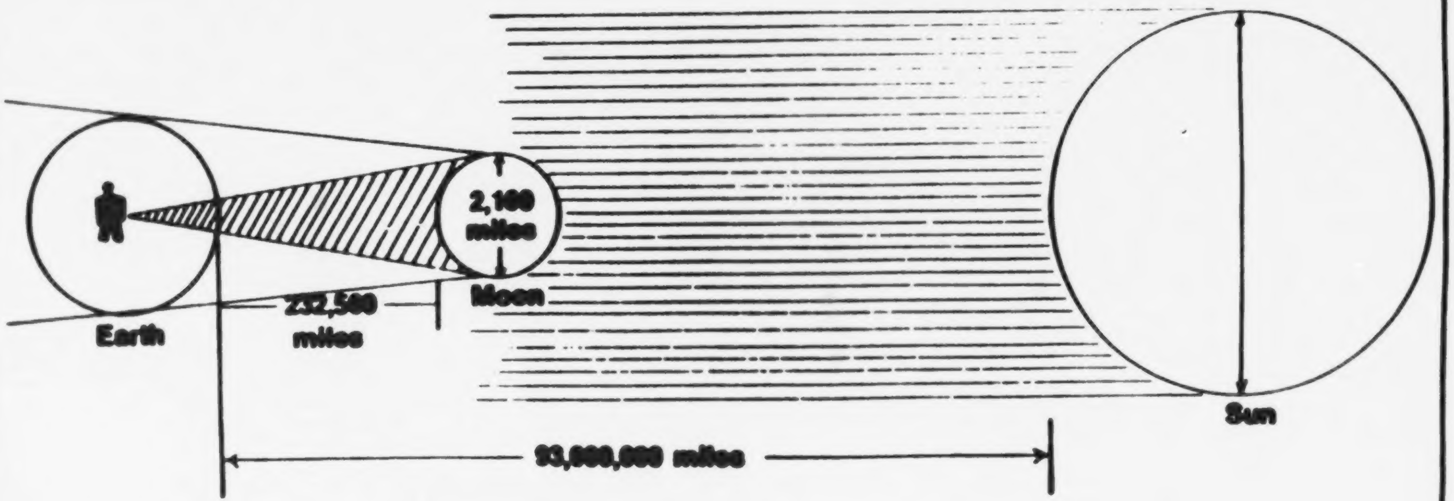
(5) Discuss the moon phase in which solar eclipses occur.

(6) Describe the characteristics of the umbra and the penumbra.

(7) Discuss the phenomena which accompany the solar eclipse; e.g. sky darkens, strange sky and landscape colors appear, stars are visible, and corona appears.

MASTER #V-2

SOLAR ECLIPSE


2,160
miles
Moon
232,500
miles
Earth
Sun
93,000,000 miles

ACTIVITY #6

TITLE: HISTORY OF ASTRONOMY

PURPOSE

To trace the development and contributions of the science of Astronomy.

OBJECTIVE

Students should be able to:

(1) Name important people in the field of astronomy.

(2) Describe important discoveries and developments in astronomy.

(3) State the importance of the science of astronomy.

MATERIALS

None.

PROCEDURE

(1) Have students draw a time line for the field of astronomy, beginning with Galileo's early observations of our planetary system.

(2) Have students highlight those discoveries and developments that had the greatest impact on the field of astronomy.

(3) Have each student choose one discovery and write a short report on its contribution to astronomy.

Unit VI
Space Exploration.

ACTIVITY #1

TITLE: CONDITIONS OF SPACE

PURPOSE

To compare the physical conditions of space to those of earth.

OBJECTIVE

Students should be able to compare and contrast the physical characteristics of space to the earth's.

MATERIALS

None.

PROCEDURE

(1) Write the following phsical factors on blackboard:

  (a) Gravity

  (b) Temperature

  (c) Light

  (d) Water

  (e) Radiation

  (f) Oxygen

(2) Have students meet in groups of three or four and discuss the physical characteristics of space and earth for each of the factors.

(3) Have each group present findings to the class.

(4) Make a chart on blackboard comparing characteristics for each factor and discuss scientific basis for the differences.

ACTIVITY #2

TITLE: SPACE LAUNCH VEHICLES

PURPOSE

To examine the types of launch vehicles and the principle on which they function.

OBJECTIVES

Students should be able to:

(1) Identify the launch vehicles used by NASA.

(2) Explain the principle of the rocket.

MATERIALS

Master #VI-1

PROCEDURE

(1) Prepare transparency of Master #VI-1 and of #VI-2.

(2) Prepare student copies of Master #VI-1 with names of launch vehicles omitted.

  (a) Have students write names of launch vehicles on handouts.

  (b) Present information on each vehicle from background material provided.

(3) Show a transparency of Master #VI-2 to explain the principle of the rocket.

DISCUSS THE FOLLOWING QUESTIONS:

  (a) What are the meanings of the terms booster, payload, thrust, LOX and escape velocity?

  (b) What is Newton's Third Law?

  (c) What is the difference between a rocket and a jet aircraft?

  (d) What two forces must a rocket overcome to achieve orbit?

  NOTE: Write to NASA for available films showing the various launch vehicles.

MASTER #VI-1

NASA Facts

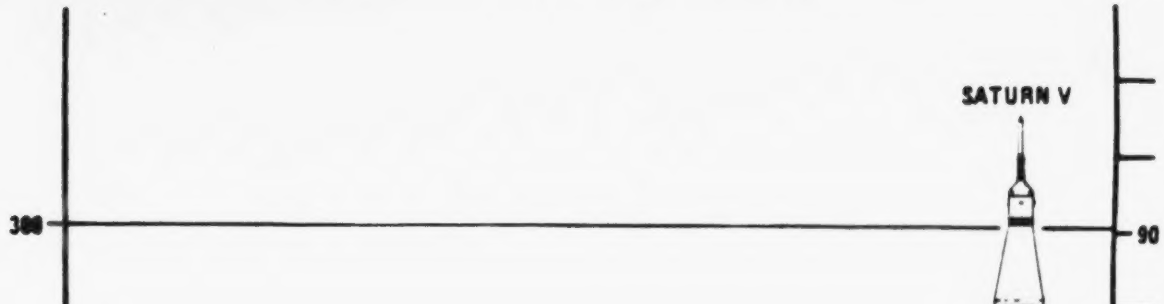
National Aeronautics and
Space Administration

BEST COPY AVAILABLE

SPACE LAUNCH VEHICLES

Whatever space mission is undertaken, the vehicle carrying the payload must be propelled into space by rocket power. All unmanned rockets currently used by NASA have more than one stage and are usually referred to as launch vehicles. The manned Space Shuttle is a unique design, and in a class by itself.

The payload weight and the planned spacecraft destination determine what rocket capabilities are required for each mission. A low-weight spacecraft designed to operate in near-Earth orbit might be flown aboard NASA's smallest space vehicle, the Scout. Sending an Apollo manned spacecraft to the Moon required the massive Saturn V. The powerful Titan-Centaur combination sent large and complex unmanned scientific explorers like the Vikings and Voyagers to examine other planets. Atlas Agenas sent several spacecraft to impact on the Moon. Atlas-Centaurs and Deltas have launched over 220 spacecraft in a wide variety of applications that cover the broad range of the national space program. Of these, only the Scout, Delta and Atlas-Centaur are still operational.



ATLAS/AGENA

The Atlas/Agena was a multi-purpose two-stage liquid propellant rocket. It was used to place unmanned spacecraft in Earth orbit, or inject them into the proper trajectories for planetary or deep-space probes.

The programs in which the versatile Atlas/Agena was utilized included early Mariner probes to Mars and Venus, Ranger photographic missions to the Moon, the Orbiting Astronomical Observatory (OAO), and early Applications Technology Satellites (ATS). The Agena upper stage also was used as the rendezvous target vehicle for the Gemini spacecraft during this series of two-man missions in 1965-1966. In preparation for the manned lunar landings, Atlas/Agena launched lunar orbiter spacecraft which went into orbit around the Moon and took photographs of possible landing sites.

The Atlas/Agena stood 36.6 meters (120 feet) high, and developed a total thrust at liftoff of approximately 1,725,824 newtons (388,000 pounds). It was last used in 1968 to launch an Orbiting Geophysical Observatory (OGO).

SATURN V

The Saturn V, America's most powerful staged rocket, carried out the ambitious task of sending astronauts to the Moon. The first Saturn V vehicle, Apollo 4, was launched on November 9, 1967. Apollo 8, the first manned flight of the Saturn V, was also the first manned flight to the Moon; launched in December 1968, it orbited the Moon but did not land. Apollo 11, launched on a Saturn V on July 16, 1969, achieved the first lunar landing.

Saturn V began its last manned mission on December 7, 1972, when it sent Apollo 17 on the final lunar exploration flight. It was last used on May 14, 1973, when it lifted the unmanned Skylab space station into Earth orbit, where it was occupied by three crews for a total of 171 days.

All three stages of the Saturn V used liquid oxygen as the oxidizer. The first stage burned kerosene with the oxygen, while the fuel for the two upper stages was liquid hydrogen. Saturn V, with the Apollo spacecraft and its small emergency escape rocket on top, stood 111 meters (363 feet) tall, and developed 34.5 million newtons (7.75 million pounds) of thrust at liftoff.

SATURN IB

The Saturn IB was originally used to launch Apollo lunar spacecraft into Earth orbit, to train for manned flights to the Moon. The first launch of a Saturn IB with an unmanned Apollo spacecraft took place in February 1966. A Saturn IB launched the first manned Apollo flight, Apollo 7, on October 11, 1968.

After the completion of the Apollo program, the Saturn IB launched three missions to man the Skylab space station in 1973. In 1975 it launched the American crew for the Apollo/Soyuz Test Project, the joint U.S./Soviet Union docking mission.

Saturn IB was 69 meters (223 feet) tall with the Apollo spacecraft and developed 7.1 million newtons (1.6 million pounds) of thrust at liftoff.

TITAN III-E/CENTAUR

The Titan III-E/Centaur, first launched in 1974, had an overall height of 48.8 meters (160 feet). Designed to use the best features of three proven rocket propulsion systems, this vehicle gave the U.S. an extremely powerful and versatile rocket for launching large spacecraft on planetary missions.

The Titan III-E/Centaur was the launch vehicle for two Viking spacecraft to Mars, and two Voyager spacecraft to Jupiter and Saturn. It also launched two Helios spacecraft toward the Sun. All provided remarkable new information about our solar system. The Vikings and Voyagers produced spectacular color photographs of the planets they explored.

The Titan III-E booster was a two-stage liquid-fueled rocket with two large solid-propellant rockets attached. At liftoff, the solid rockets provided 10.7 million newtons (2.4 million pounds) of thrust.

The Centaur stage, still in use today, produces 133,440 newtons (30,000 pounds) of thrust from two main engines, and burns for up to seven and one-half minutes. The Centaur can be restarted several times, which allows for more flexibility in launch times.

CURRENT LAUNCH VEHICLES

At present the Kennedy Space Center conducts operational launches of the Delta and Atlas-Centaur vehicles, and of the Space Shuttle. The Delta and Atlas-Centaur are launched from NASA pads on the Cape Canaveral Air Force Station, and Space Shuttles from Kennedy. Scout rockets are launched from the Western Test Range and the San Marco launch complex off the east coast of Africa.

Many of the launches conducted by NASA are for commercial organizations, other Federal agencies, other nations, or multi-national groups such as the International Telecommunications Satellite Organization. NASA is reimbursed for the cost of the rocket and launch services for such missions.

DELTA

Delta is called the workhorse of the space program. This vehicle has successfully transported over 160 scientific, weather, communications and applications satellites into space. These include the TIROS, Nimbus and ITOS weather observers; the Landsat Earth resources technology satellites; the early Intelsat international communications satellites; and many Explorer scientific spacecraft.

First launched in May, 1960, the Delta has been continuously upgraded over the years. Today it stands 35.4 meters (116 feet) tall. Its first stage is augmented by nine Caster IV strap-on solid propellant motors, six of which ignite at liftoff and three after the first six burn out 58 seconds into the flight. The average first-stage thrust with the main engines and six solid-propellant motors burning is 3,196,333 newtons (718,000 pounds). Delta has liquid-fueled first and second stages and a solid-propellant third stage. For most launches today, this third stage has been replaced by a Payload Assist Module (PAM) stage attached to the spacecraft.

The new PAM upper stage is also used on Space Shuttle launches. It boosts spacecraft from the low Earth orbit achieved by the Shuttle orbiter into higher ones. Many spacecraft, especially communications satellites, operate in a geosynchronous (geostationary) orbit some 35,792 kilometers (22,240 miles) above the equator. With the PAM and a recent change to a more powerful second stage, the Delta can lift some 1,270 kilograms (2,800 pounds) into a highly elliptical orbit, for transfer into geosynchronous orbit by a motor built into the spacecraft. This is almost double the 680 kilograms (1,500 pounds) a Delta could manage only seven years ago.

Delta vehicles were developed under the direction of NASA's Goddard Space Flight Center at Greenbelt, Maryland, and are built by the McDonnell Douglas Corporation.

ATLAS/CENTAUR

The Atlas/Centaur is NASA's standard launch vehicle for intermediate payloads. It is used for the launch of Earth orbital, geosynchronous, and interplanetary missions.

Centaur was the nation's first high-energy, liquid-hydrogen liquid-oxygen launch vehicle stage. It was developed under the direction of NASA's Lewis Research Center at Cleveland, Ohio, and became operational in 1966 with the launch of Surveyor 1, the first U.S. spacecraft to soft-land on the Moon.

Since 1966, both the Atlas booster and the Centaur second stage have undergone many improvements. At present, the combined stages can place over 4,530 kilograms (10,000 pounds) in low-Earth orbit, about 2,020 kilograms (4,453 pounds) in geosynchronous transfer orbit, and over 1,000 kilograms (2,206 pounds) on an interplanetary trajectory.

An Atlas-Centaur stands 41.9 meters (137.6 feet) tall. At liftoff, the Atlas booster develops over 1.9 million newtons (438,400 pounds) of thrust. The Centaur second stage develops 146,784 newtons (33,000 pounds) of thrust in a vacuum. General Dynamics/Convair is the prime contractor for Atlas/Centaur.

Spacecraft launched by Atlas/Centaurs include Orbiting Astronomical Observatories; Applications Technology Satellites; Intelsat IV, IV-A and V communications satellites; Mariner Mars orbiters; a Mariner spacecraft which made a fly-by of Venus and three of Mercury; Pioneer spacecraft which accomplished fly-bys of Jupiter and Saturn and Pioneers that orbited Venus and plunged through its atmosphere to the surface.

SCOUT

The Scout launch vehicle, which became operational in 1960, has been undergoing systematic upgrading since 1976. The standard Scout vehicle is a solid-propellant, four-stage booster system approximately 23 meters (75 feet) in length with a launch weight of 21,600 kilograms (46,620 pounds) and liftoff thrust of 588,240 newtons (132,240 pounds).

Recent improvements include an uprated third-stage motor which increases the Scout's payload capability. It can now place up to 211 kilograms (465 pounds) in low-Earth orbit. The third stage has also been provided with an improved guidance system.

The Scout has been used to place a variety of U.S. and international payloads into inclined, equatorial, and polar orbits for orbital, probe, and re-entry missions. Launches have occurred at the Wallops Flight Facility off the coast of Virginia; at Vandenberg; and at San Marco, a manmade platform off the coast of eastern Africa.

Scout vehicles were developed under the direction of NASA's Langley Research Center at Hampton, Virginia. They are built by the Vought Corporation, Systems Division. Over 100 Scouts have been launched to date. Langley is in charge of launches at Vandenberg, while Scouts at San Marco are launched by visiting teams from Italy.

SPACE SHUTTLE

On April 12, 1981, the first Space Shuttle vehicle lifted off from Launch Complex 39, Pad A, at the Kennedy Space Center. After a two-day test-flight mission that verified the vehicle's ability to function in space, the Orbiter Columbia landed at Edwards Air Force Base in California. This was the first time astronauts had been launched on a new space vehicle on its first flight. The vehicle functioned extremely well, proving its ability to perform as the major NASA launch vehicle for the indefinite future.

Preparations to launch the Space Shuttle at the Kennedy Space Center required extensive modifications to some facilities, such as the Vehicle Assembly Building and two launch pads, but only two completely new structures. One was a 4,600-meter (15,000-foot) runway, and the second was a highly specialized hangar called the Orbiter Processing Facility. In 1985 a new logistics facility and solid rocket booster refurbishment building were added at Launch Complex 39.

The Space Shuttle consists of a reusable delta-winged spaceplane called the orbiter; two solid-propellant rocket boosters, which are recovered and also reused; and an expendable external tank containing liquid propellants for the orbiter's main engines. The tank contains separate compartments to house liquid hydrogen (fuel) and liquid oxygen (oxidizer).

At launch, the orbiter's three liquid-fueled rockets—drawing propellants from the external tank—and the two solid rockets burn simultaneously. Together, they generate 30 million newtons (6.7 million pounds) of thrust. As the Space Shuttle reaches an altitude of about 50 kilometers (31 miles), the spent solid rockets are detached and parachute into the ocean for recovery and reuse. The orbiter and tank continue toward Earth orbit. When the orbiter's main engines cut off, just before orbit is achieved, the external tank is jettisoned, to impact in a remote ocean area. Using on-board orbital maneuvering engines, the orbiter with its crew and payload accelerates into orbit to carry out an operational mission, normally lasting from two to seven days.

When the mission has been completed, the orbiter re-enters the atmosphere and returns to Earth. Like a glider, it sails through the air to make an unpowered landing. Touchdown speed is above 335 kilometers (210 miles) per hour.

The assembled Shuttle vehicle is approximately 56 meters (184 feet) long and 23.3 meters (76 feet) high. The orbiter measures about 37 meters (122 feet) long and has a wingspan of around 24 meters (78 feet). Its payload bay is 18.3 meters (60 feet) long and 4.6 meters (15 feet) wide.

The builder of the Space Shuttle orbiters is Rockwell International. The solid rocket boosters are built by Morton Thiokol, and Martin Marietta builds the external tank. The contractor for overall integration and checkout at KSC is Lockheed Space Operations Company. The Lockheed team includes Grumman Technical Services, Pan American World Airways, and Morton Thiokol.

The Space Shuttle completed its fourth flight in July 1982 and was declared an operational vehicle. By the end of 1984 it had completed an additional eleven missions and was approaching an interim goal of a flight per month (average). It is now the nation's major launch vehicle for civilian, military, and government payloads. It also carries many international civilian and government payloads into space. The Shuttle cargo manifest for the next several years is already filled with science and applications payloads for private industry, universities, and research organizations, as well as small scientific payloads for individuals. The most ambitious continuing science research program in space is based on the Spacelab, a joint NASA-European Space Agency manned laboratory which rides inside the orbiter cargo bay.

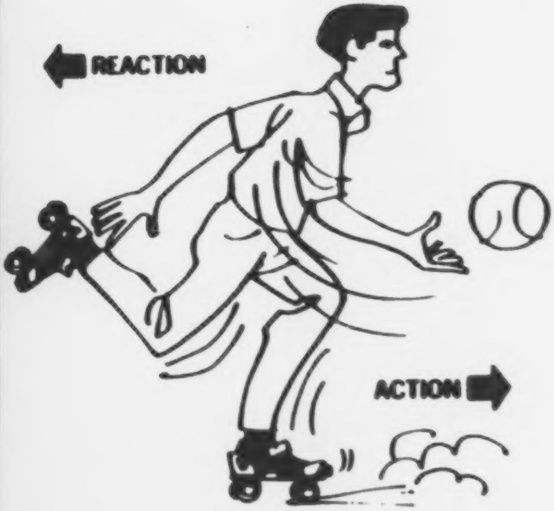
Most of the operational spacecraft launched on the Shuttle are sent onto geosynchronous orbit, at about 35,888 kilometers (22,300 miles) above the equator. This requires that each spacecraft have an attached independent rocket stage. After separating from the orbiter in low earth orbit this stage is ignited and sends the spacecraft into an elliptical transfer orbit, with its top at geosynchronous altitude. A small motor on board the spacecraft then fires to circularize the orbit. An attached stage of this type can also be used to send spacecraft into interplanetary trajectories.

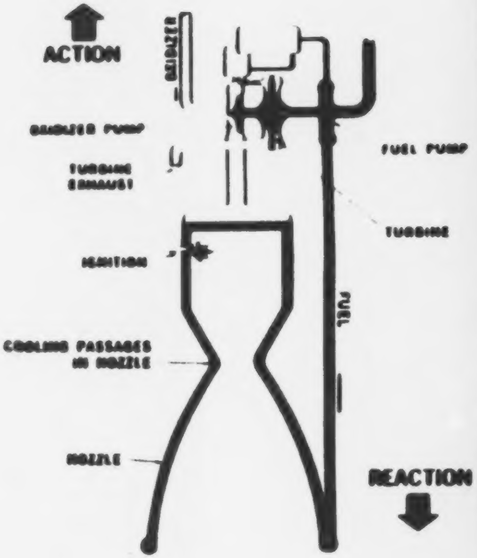
Each Shuttle orbiter has been designed for at least 100 missions. Because of its versatility and reusability, the Shuttle significantly reduces the cost of placing spacecraft in orbit.

Shuttles are launched into east-west orbit from the Kennedy Space Center in Florida. In 1986 north-south orbital flights will originate from Air Force facilities at Vandenberg A.F.B. in California.

MASTER #VI-2

ROCKET PRINCIPLE


REACTION
ACTION


ACTION
OXIDIZER
OXIDIZER PUMP
TURBINE EXHAUST
IGNITION
COOLING PASSAGES IN NOZZLE
NOZZLE
FUEL PUMP
TURBINE
FUEL
REACTION

The push which the rocket vehicle receives from gases expanding out of the engine's nozzle is explained in Newtons third law of motion: "For every action there is an equal and opposite reaction." This can be illustrated by envisioning a skater standing upright with a bowling ball held near his body. He pushes the ball away. The ball goes flying one way and he will go flying the other way. The faster he pushes the ball away, the harder he will be pushed in the opposite direction. All rockets work on this principle.

ACTIVITY #3

TITLE: SATELLITE ORBITS

PURPOSE

To construct a diagram of satellite orbits.

OBJECTIVES

Students should be able to:

(1) Diagram the orbits of satellites.

(2) Locate the perigee and apogee of a satellites orbit.

(3) Compare the period of revolution of satellites.

MATERIALS

(1) Graph Paper

(2) Ruler

(3) Compass

(4) Colored Pencils

BACKGROUND INFORMATION

The orbits of man made earth satellites, like the orbits of the natural moons, planets, and comets of the solar system, are elliptical. As such, their distances from the earth and speed of revolution change steadily through each revolution around the earth. The point at which the satellite approaches closest to the earth is its perigee (peri, near; gee, earth). The point at which the satellite is farthest from the the earth is its apogee (apo, away).

In this exercise, the student will construct and study a scale diagram of the orbits of three satellites (X, Y, Z).

PROCEDURE

The Earth

(1) Using a scale of 1 inch to 2000 miles (1/4 inch = 500 miles), draw a circle a t the center of your paper to represent the earth. Assume a radius of 4000 miles for the earth. Place arrows at left and right sides of the earth to show its counter clockwise rotation.

The Sun

(2) Hold the paper with long edge from left to right. At the left edge, draw horizontal arrows two inches long and one inch apart, (starting at the center of the edge) to represent sun's rays. Label them.

The Earth's Shadow

(3) Divide the earth in half by a verticle diameter (twilight line), through its center. From the ends of the diameter draw horizontal lines to the right edge of the paper to mark off the earth's shadow. Lightly shade the right half of the earth and its shadow. Just inside the earth, label Noon, Sunset, Midnight and Sunrise at the proper points

Orbit of Satellite X

(4) Using the scale indicated, place a dot to the right of the earth to show Satellite X's apogee distance from the surface, and another dot to the left of the earth to show Satellite X's perigee distance. Above and below the earth, place dots at the average of the two distances. Join these four fots by hand with a smooth ellipse. (The ellipse should approach the earth's surface gradually from apogee to perigee. Label the ellipse "Orbit of Satellite X."

Orbit of Satellite Y

(5) Plot the orbit of Satellite Y in the same way as you did that of Satellite X. Draw the orbit in red pencil or by a broken line. Label it "Orbit of Satellite Y."

Orbit of Satellite Z

(6) Since this is circular, it may be drawn with your compass. Label it "Orbit of Satellite Z."

NOTE: If Satellite Z's orbit was at a distance of 22,500 miles from earth, it would be in a synchronous orbit.

Student Guide Questions

(7) Examine the three satellite orbits and determine:

(a) At which location and at what time the satellites are visible.

(b) At which location and at what time the satellites are invisible.

(c) At which location and at what time the satellites are eclipsed by the earth's shadow.

(8) Examine the three satelite orbits and determine:

(a) Which satellite has the shortest orbital period.

(b) Which satellite has the longest orbital period.

(c) Which satellite would have the longest life expectancy. Why?

ACTIVITY #4

TITLE: LIVING IN SPACE

PURPOSE

To examine the life support systems and problems encountered on a spaceflight.

OBJECTIVE

Students should be able to:

(1) Describe the life support systems needed to survive in space.

(2) List and discuss problems that astronauts may encounter during a space flight.

MATERIALS

NASA FACTS "Living In Space" (See C.G. p. 43)

NASA Films on space flight (See C.G. p. 43)

Master #VI-3

PROCEDURE

Life Support Systems

(1) Produce a transparency and student copies of Master #VI-3.

(2) Identify each life support system pictured using the following key:

(a) oxygen recovery

(b) air pressure

(c) water

(d) contaminant removal

(e) food

(f) waste disposal

(g) power

(h) hygiene

(i) thermal control

(j) instrumentation and control

(3) Instruct students to discuss the need for each system and problems created for astronauts in the event of a malfunction.

Astronaut Problems in Space

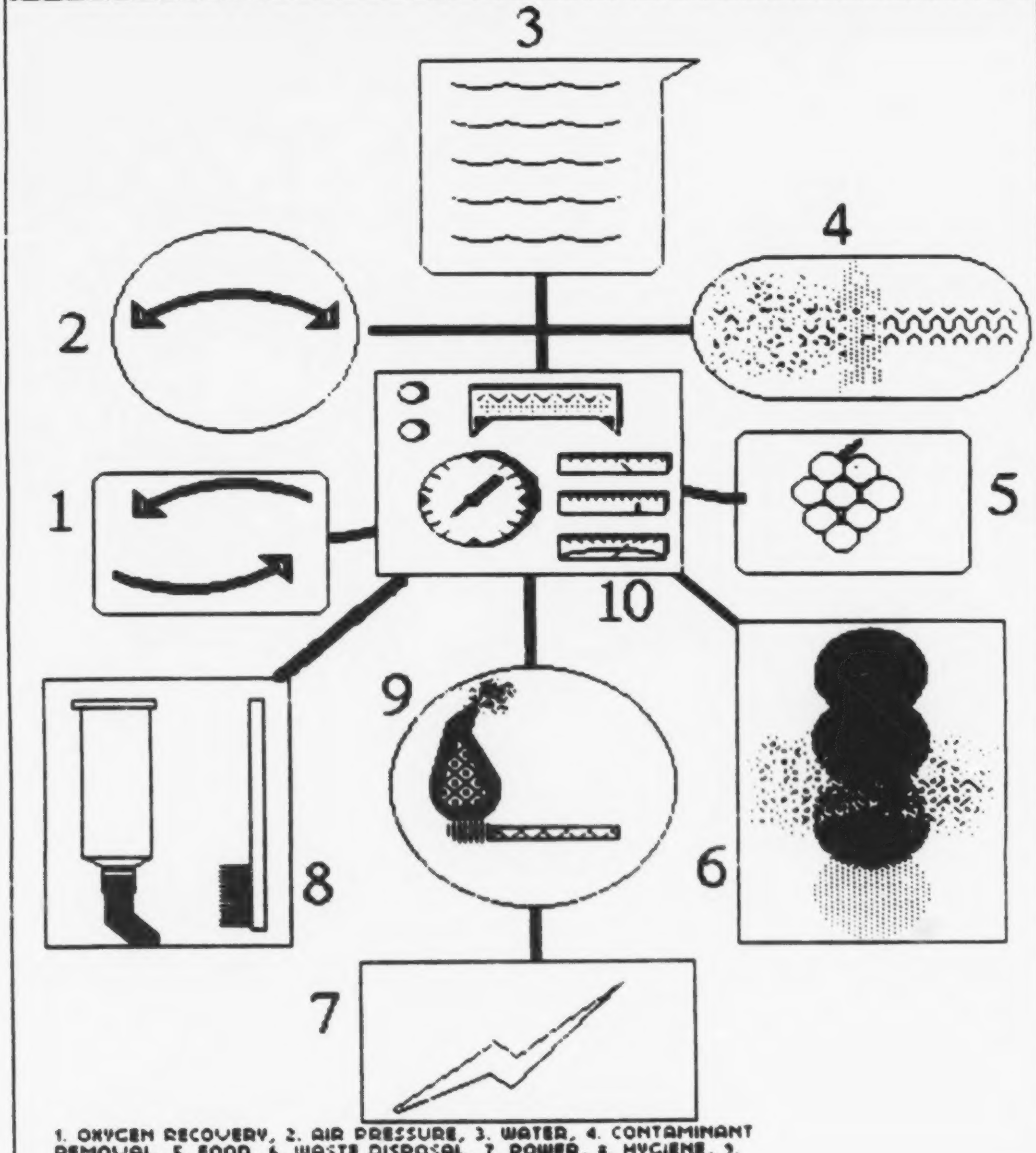
(4) Assign students to meet in groups of three or four and compile a list of problems astronauts may encounter on a space flight.

(a) Make a list of student answers on blackboard and discuss source of problem and precautions taken by astronauts. **NOTE**: Answers should include the following:

(a) "g" force at lift off
(b) engine malfunction
(c) temperature extremes
(d) radiation
(e) medical needs
(f) weightlessness
(g) sleep
(h) communication
(i) proper exercise
(j) psychological (stress and confinement)
(k) re-entry

MASTER #VI-3

Inter-dependence of Life Support Functions.



1. OXYGEN RECOVERY, 2. AIR PRESSURE, 3. WATER, 4. CONTAMINANT REMOVAL, 5. FOOD, 6. WASTE DISPOSAL, 7. POWER, 8. HYGIENE, 9. THERMAL CONTROL, 10. INSTRUMENTATION AND CONTROL.

ACTIVITY #5

TITLE: SPACE SHUTTLE PROGRAM

PURPOSE

To examine the design, flight sequence accomplishments, and future uses of the space shuttle.

OBJECTIVES

Students should be able to:

(1) Explain the main components of the shuttle.

(2) Explain the steps in the flight of the space shuttle.

(3) List and describe the importance of space shuttle accomplishments to date.

(4) Discuss proposed future space shuttle uses.

MATERIALS

NASA Educational Briefs
Master # VI-4, #VI-5, #VI-6

PROCEDURE

(1) Prepare transparencies of Masters #VI-5, #VI-6 and student copies with labels omitted.

(2) Prepare student copies of Master #VI-4.

(3) Have students read the NASA Educational Briefs article "Space Shuttle Statistics" and complete the "Activities and Questions for the Classroom" section.

(4) Have students answer question #1 using the shuttle diagram and question #4 using the shuttle mission diagram.

(5) Have two or three students conduct library research and present oral class reports on the following topics:

  (a) Describe the importance of the space shuttle and the contributions of the shuttle program thus far.

  (b) Describe proposed future uses of the space shuttle.

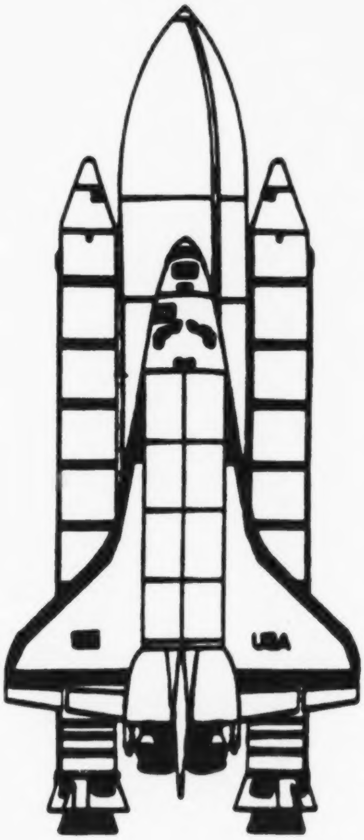
MASTER #VI-4

NASA Educational Briefs

For the
classroom

An Educational
Publication
of the
National Aeronautics
and Space Administration

Space Shuttle Statistics



The Space Shuttle is NASA's first true aerospace vehicle. It will take off as a rocket, operate in orbit as a spacecraft, and land on the Earth as an airplane. The Shuttle is a four part vehicle consisting of the Orbiter, an expendable External Tank (ET), and two Solid Rocket Boosters (SRB's).

Launched in a conventional manner, the Space Shuttle's Main Engines (SSME's) and the SRB's produce approximately 30,800,000 newtons of thrust. At 45 kilometers above the Earth the boosters separate and return to the Earth by parachute for sea recovery. Eight minutes into the flight, at an approximate altitude of 110 kilometers, the ET propellants are exhausted. The tank will separate from the Orbiter and disintegrate upon reentry into the Earth's atmosphere. Any surviving pieces fall into remote ocean areas. To complete orbital insertion to altitudes between 160 and 1100 kilometers, and later to make orbital adjustments, two Orbital Manuvering System (OMS) engines fire.

Once in space, the Space Shuttle Orbiter serves as a base to deploy payloads such as satellites or space probes. Satellites needing repair or servicing can be brought on board and later released or returned to Earth. The Orbiter can also be used as a platform for scientific research.

At the completion of the orbital phase of the mission, the Orbiter is rotated in space by firing combinations of small rockets called the Reaction Control System (RCS). When the OMS engines are aimed in the direction of motion, they fire and the resulting thrust slows the Orbiter, initiating reentry. Before making atmospheric contact, the Orbiter is again rotated so that the underside will experience the major share of atmospheric friction. To protect the Orbiter, three types of reusable surface insulation are used. In areas of greatest heating, the nose area, and the leading edges of the wings, reinforced carbon is used (carbon cloth impregnated with additional carbon, heat treated, and then coated with silicon carbide). Other areas are covered with thermal tiles made of silica fibers or a Nomex felt blanket material (nylon felt coated with silicon). To aid in heat rejection, the tiles are given a glassy ceramic coating.

As the altitude and speed of the orbiter decreases, the Orbiter begins to function as a glider. The glide angle to the runway is about six times steeper than a commercial jet liner on landing approach. Landing speeds are approximately 340 kilometers per hour

Following landing, the Orbiter undergoes refurbishment, new payloads are inserted, a new External Tank installed, the boosters refueled and the entire vehicle assembly is made ready for a new launch a few weeks later. To reduce cost, the Orbiter is designed to be used again for up to 100 missions and the SRB's are designed for 20 flights each.

Solid Rocket Boosters

The SRB's provide the major portion of the thrust at the time of liftoff. They are the largest solid rocket boosters ever built, the first to be used to launch humans into space, and the first designed for reuse. The SRB's are assembled out of four tubular segments of 1.25 centimeter steel. The fore end is capped with a nose cone containing a parachute assembly. The aft end has a steerable nozzle. Eight small rocket motors, four in the nose and four aft, are used, at burn out, to separate the SRB's from the external tank.

Each booster contains a solid propellant that looks and feels like the hard rubber of a typewriter eraser. A hollow core runs the entire length of the propellant load. To ignite the propellants, a small rocket motor, fixed at the fore end of the core, is fired first. Flames from the small rocket spread across the entire face of the core and the SRB's come to full thrust in less than one-half of a second.

Statistics

Length: 45.46 meters

Diameter: 3.70 meters

Mass empty: 82,879 kilograms each

Propellant mass: 503,627 kilograms each

Thrust: 12,899,200 newtons each at sea level

Nozzles: Covergent-divergent. All-axis gimbaling of 8°.

Propellant composition:
  Aluminum perchlorate powder (oxidizer)
  Aluminum powder (fuel)
  Iron oxide (catalyst)
  Polymer (binder and fuel)
  Epoxy curing agent

SRB Surface Insulation: Ablative

External Tank

The external tank contains the propellants used for liftoff and ascent by the Shuttle Orbiter's three main engines. The ET has an external shell which encloses three inner tanks. The forward inner tank contains liquid oxygen under pressure. An unpressurized intertank holds most of the electrical components. The aft inner tank contains liquid hydrogen under pressure. Tank walls are manufactured of aluminum alloys and are up to 5.23 centimeters thick. Antivortex and antislosh baffles are built inside the fore and aft tank walls to dampen any motions of the liquid propellants that might throw the Shuttle off course.

Propellants are fed to the Orbiters SSME's by gas pressure derived from the controlled boiling of the propellants. Following the depletion of liquid propellants, the ET is destroyed on atmospheric reentry.

Statistics

Length: 47 meters

Diameter: 8.38 meters

Mass empty: 37,482 kilograms

Propellants:
  Liquid oxygen (LO_2)
  Liquid hydrogen (LH_2)

Propellant mass:
  LO_2 .. 603,196 kilograms
  LH_2 .. 101,606 kilograms

Propellant feed lines: (2) 43 centimeters in diameter

Propellant feed rate:
  LO_2 .. 242,000 liters per minute
  LH_2 .. 184,420 liters per minute

Surface insulation: 1.27 centimeters thick cork/epoxy layer covered with a 2.54 to 5 centimeter thick Spray-on foam.

Orbiter

The Space Shuttle Orbiter is a wide-body, delta-winged airplane and space vehicle. It is constructed primarily out of aluminum and covered with reusable surface insulation. The Orbiter is propelled by 49 rocket engines employed in various combinations for liftoff, attitude control in space, and in initiating reentry. Electrical power for Orbiter systems is provided by fuel cells which produce, as a byproduct, water for drinking.

The heart of the Orbiter is the cargo bay which can carry up to four satellites for launching at one time. The cargo bay permits the science laboratory Spacelab, to be carried into space and returned to the Earth at the completion of a mission. A highly articulated mechanical arm called the Remote Manipulator System (RMS), can be operated by Shuttle astronauts while inside the Orbiter cabin. The arm will be used to extract payloads from the cargo bay and deploy them outside of the Orbiter.

The forward section of the Orbiter contains the flight deck and crew quarters for the astronauts. During launch up to four astronauts may sit on the flight deck and up to three more may sit on the crew quarters deck. The forward portion of the flight deck resembles the cockpit of a jet liner but features separate controls for flying in space and flying in the atmosphere. The aft portion of the flight deck contains four stand-up duty stations including the controls for the RMS. The crew quarters deck is entered through an open hatch through the flight deck floor. The crew quarters contain eating, sleeping, and sanitary facilities. When extravehicular activities are necessary, an airlock is installed in the orbiter cargo bay and entry is gained through a hatch in the crew quarters.

Statistics

Exterior dimensions

Length: 37.24 meters

Body Width: 6.9 meters

Wingspan: 23.79

Height with gear extended: 17.27 meters

Mass empty: 68.040 (Orbiter 102. Future orbiters will have lower masses.)

Cargo Bay length: 18.28 meters

Cargo Bay diameter: 4.57 meters

Payload mass for launch: 29.484 kilograms to low Earth orbit

Payload mass on return: 14.515 kilograms

Engines

SSME: 3

Liquid hydrogen and liquid oxygen propellants
Gimbaling ± 10.5° on pitch axis and ± 8.5° on yaw axis
Thrust: 1,668.000 newtons each at sea level

OMS: 2
Nitrogen tetroxide (N_2O_4) and monomethyl hydrazine (MMH) propellants
Thrust: 26.688 newtons each in a vacuum

RCS:
Primary Thrusters
38 (14 fore and 24 aft)
N_2O_4 and MMH propellants
Thrust: 3870 newtons each in a vacuum
Vernier Thrusters
6 (2 fore and 4 aft)
N_2O_4 and MMH propellants
Thrust: 106 newtons each in a vacuum

Crew Quarters (2 decks)
Cabin volumn: 71.5 meters^3
Atmosphere: normal
Pressure: normal

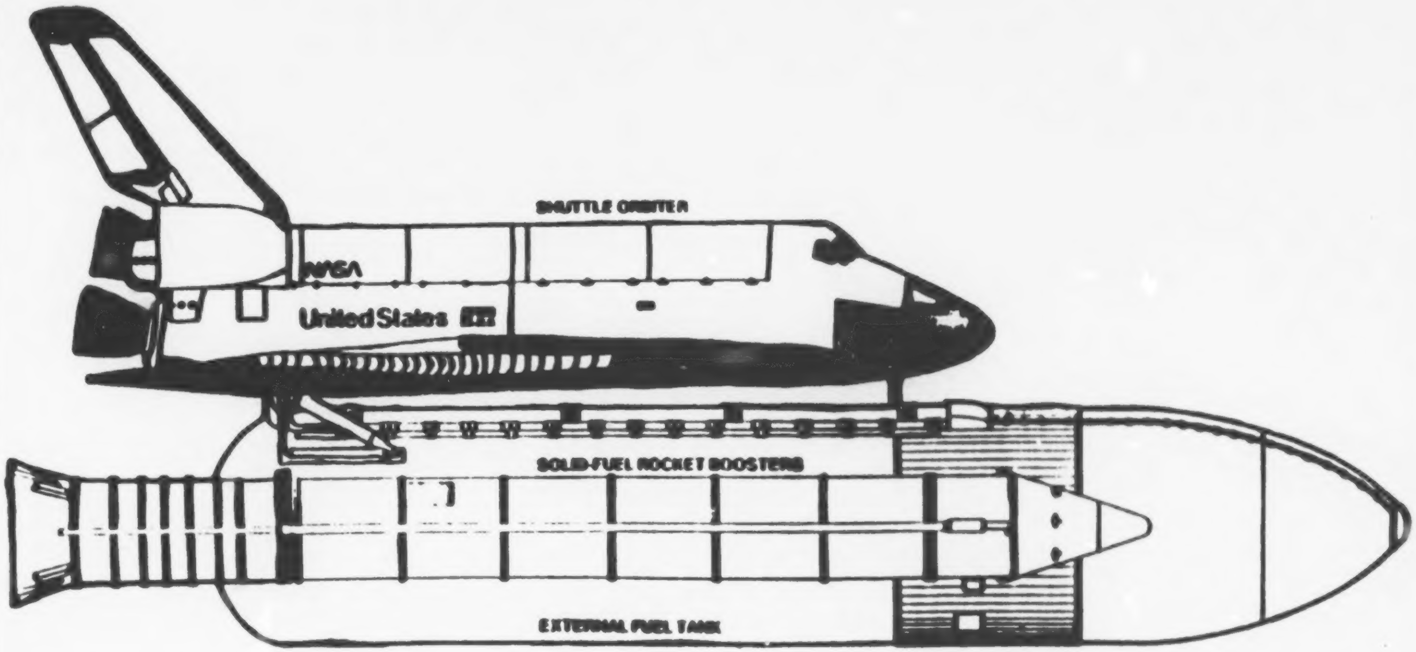
Thermal Protection System
Reusable
RCC, coated silica tiles, and coated Nomex felt.

Activities and Questions for the Classroom

1. What are the four main parts of the Space Shuttle?
2. What is the major cost saving feature of the Space Shuttle over previous launch vehicles?
3. Describe the sequence of events for the Space Shuttle from launch to landing.
4. Compare the mass of the Space Shuttle empty to the mass of all the propellants used to thrust it up into space. Why is there such a difference between the two masses?
5. What is a newton of thrust in English system measurement?
6. Illustrate the size of the Orbiter by measuring and marking its outline on a large open area such as an athletic field or playground.
7. Why is the thrust for some rocket engines listed as "sea level" and for others as "vacuum"?
8. What is the volume of the cargo bay of the Orbiter?
9. Research previous launch vehicles and compare their sizes and payload capacities to the Space Shuttle.
10. What is the orbital altitude range of the Space Shuttle?

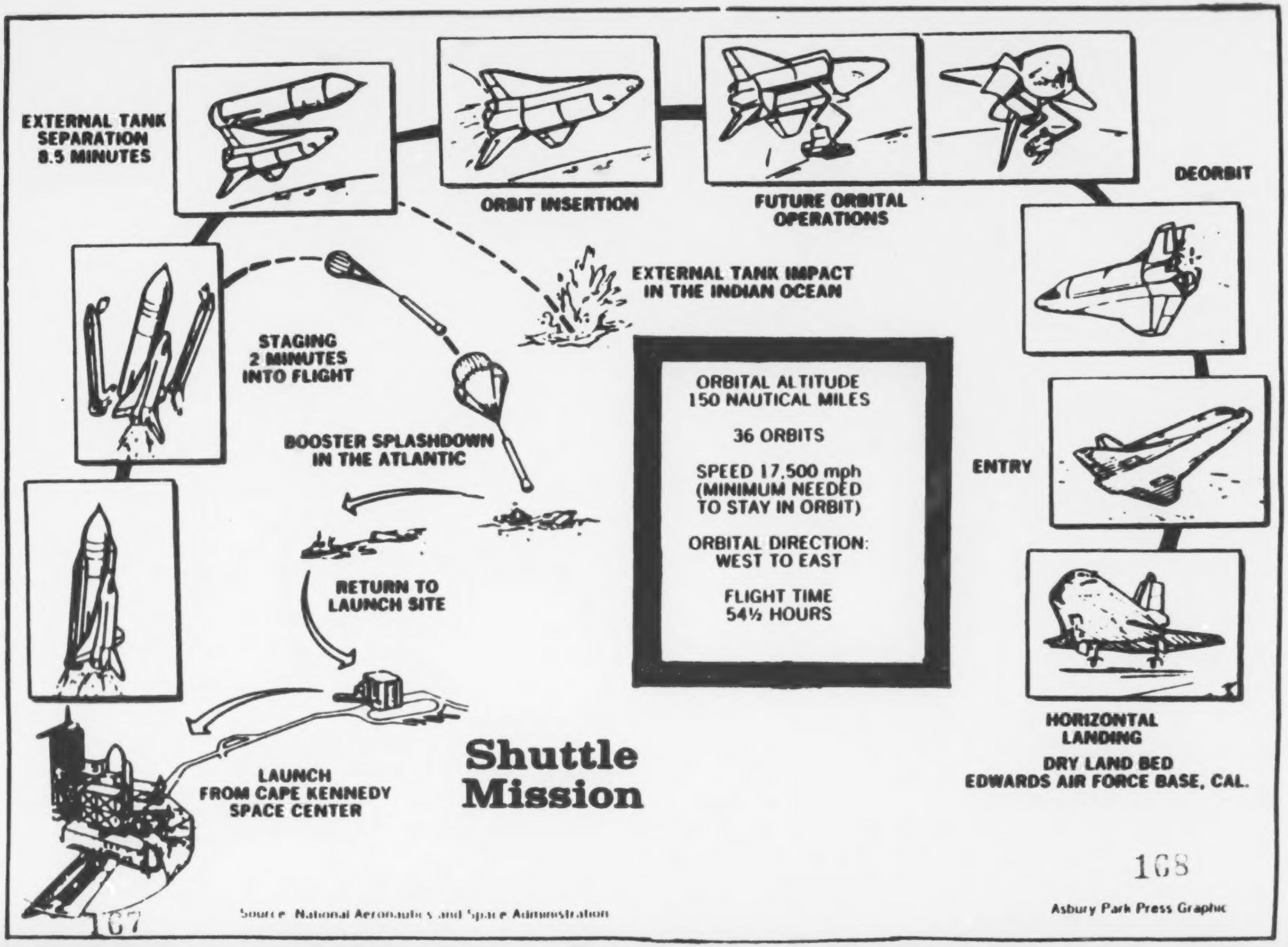
MASTER #VI-5

THE SPACE SHUTTLE


SHUTTLE ORBITER
NASA
United States
SOLID-FUEL ROCKET BOOSTERS
EXTERNAL FUEL TANK

Source National Aeronautics and Space Administration

MASTER #VI-6


EXTERNAL TANK SEPARATION 8.5 MINUTES
ORBIT INSERTION
FUTURE ORBITAL OPERATIONS
DEORBIT
EXTERNAL TANK IMPACT IN THE INDIAN OCEAN
STAGING 2 MINUTES INTO FLIGHT
BOOSTER SPLASHDOWN IN THE ATLANTIC
ENTRY
RETURN TO LAUNCH SITE
HORIZONTAL LANDING
DRY LAND BED
EDWARDS AIR FORCE BASE, CAL.
LAUNCH FROM CAPE KENNEDY SPACE CENTER

ORBITAL ALTITUDE
150 NAUTICAL MILES

36 ORBITS

SPEED 17,500 mph
(MINIMUM NEEDED
TO STAY IN ORBIT)

ORBITAL DIRECTION:
WEST TO EAST

FLIGHT TIME
54½ HOURS

Shuttle Mission

Source: National Aeronautics and Space Administration

Asbury Park Press Graphic

168

167

ACTIVITY #6

TITLE: WORKING AND STUDYING IN SPACE

PURPOSE

To examine the diversity of jobs required to plan, build, operate, and maintain a space flight.

OBJECTIVES

Students should be able to:

(1) To identify job opportunity in the space industry.

(2) To apply decision-making in small groups.

(3) To discuss the interdependence of personnel in completing a project.

MATERIALS

Classified Advertisements

ACTIVITY #6A

PROCEDURE

(1) Introduce the concept of jobs by displaying pictures of a Shuttle, Space Station, or satellite. Have students list the kinds of jobs it takes to design, build, operate, and maintain a Shuttle, Space Station, or satellite. Discuss a misconception that the only space-related jobs are for astronauts. Divide the students into small groups to list as many as they can think of under each category. Have each group appoint a recorder.

(2) Copy each job onto an index card. On the bottom of the card, identify the job according to one of the four categories and have each student select a card to research.

(3) Have students make oral, first person reports on the jobs, including the job qualifications and training.

(4) Divide students into groups according to their job category on the spacecraft. Give each group an assignment that will require cooperation and interdependence. The assignment could be to design, to build, to launch and operate the craft, and to maintain it before and after launch. Note that groups will have to choose leaders and individuals to meet with other groups to keep the groups coordinated. Assign two students to observe the activities of all four groups and to comment on the following:

(a) How the students made decisions within their own groups.

(b) How the groups communicated with other groups.

(c) Whether the completed plans work reflected cooperation and organization.

(d) Whether individuals performed the work required by their assigned jobs.

The groups should keep written records of their ideas and decisions, list assignments on chart paper, and sketch plans and designs to be displayed and shared.

(5) Have each group present its work to the entire class. Ask the two students observers to present their comments and to accept explanations and rebuttals from the groups. Have students prepare oral or written statements on the following topics:

(a) The importance of any job in completing tasks.

(b) How decisions are made in completing a task.

(c) How individual workers perform their jobs with others as they try to complete a task.

ACTIVITY #6B

PROCEDURE

(1) Distribute pages of classified advertisements to the class.

(2) Divide the class into small groups to write want ads for each of the jobs on the crew of a space shuttle.

(3) Post the ads.

(4) Discuss whether they know of individuals who could meet the qualifications they set.

ACTIVITY #6C

PROCEDURE

(1) Ask students to think about their interest and to choose two jobs related to space that they think they would like to do.

(2) Have students research the skills and training necessary to fulfill the jobs.

(3) Have students draw up job applications.

(4) Have students apply for a job in space.

ACTIVITY #7

TITLE: THE BENEFITS AND COSTS OF THE SPACE PROGRAM

PURPOSE

To examine space program spinoff technologies.

OBJECTIVE

Students should be able to:

(1) List examples of recent spinoffs of the space program.

(2) Locate information on specific products and report how they are linked to the space program.

(3) Analyze technological and economic impact of spinoffs.

MATERIALS

Library Resources (Space Program)

ACTIVITY #7A

PROCEDURE

(1) Give some examples of recent spinoffs of the space program, including microminiaturization of electronics, lightweight materials, solar panels, computerized scanning medical devices, portable x-ray machines, automanic utility meter reading devices, compact water filters, automatic cash inventory registers, high intensity lights, water-cooled headbands, fabrics made of strong chemical bonds, and microcomputer software.

(2) Have students research their own list.

(3) Have teams of students report on an item, whether the work it does was possible before its space application, and how the work it does changes lifestyles on Earth.

(4) Have the students illustrate their reports.

AVTIVITY #7B

PROCEDURE

Have students pursue spinoff technologies in more detail. Teachers can locate materials through NASA Teacher Resource Centers.

(1) Assign a group of students to develop a catalog of spinoff products.

(2) Have students locate information on specific products and report how they are linked to the space program, e.g., fabric used for the Pontiac (Detroit) Silverdome, heat absorbing clothes for athletes, NASTRAN computer structural analysis program, and plastic welding.

(3) Challenge students to create a "Technological/Economic Impact" statement highlighting and analyzing the impact of spinoffs. This could be reported in traditional oral or written formats or as a video news report format. Challenge a second group of students to create the opposite scenario, "What If We Had Not Pursued the Space Program" and to report it in a "Point-Counterpoint" format.

(4) Weather satellites are another benefit of space technology. Students may wish to research and report the following areas: forecasting, television reporting, the meteorological satellite system, economic impacts of weather satellites, and the potential issue of controlling the weather. Students could prepare video news reports or "white papers" on controversial aspects of the topic.

Unit VII

Human Behavior.

ACTIVITY #1

TITLE: THE CENTRAL NERVOUS SYSTEM

PURPOSE:

To examine the parts of the central nervous system and how they function.

OBJECTIVE:

Students should be able to identify and describe the function of the parts of the central nervous system.

MATERIALS:

Master #VII-1, film, filmstrip, videotape on human brain (see curriculum guide pp.47-48).

PROCEDURE:

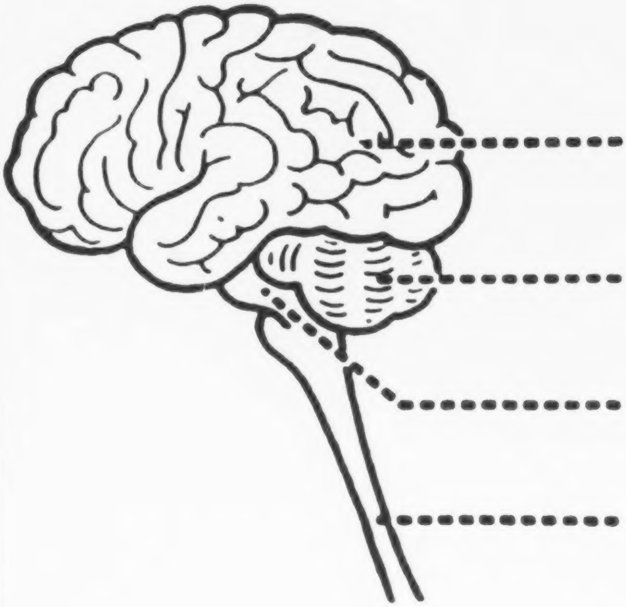
1) Introduce the central nervous system through the use of an audio-visual aid.

2) Produce a transparency and student copies of Master #VII-1.

3) Have students identify the parts of the central nervous system.

4) Have students describe the function of each part of the central nervous system.

THE HUMAN BRAIN



Function

(1) ....

....

(2) ....

....

(3) ....

....

(4) ....

....

What does each part of your nervous system do? The drawing shows four parts of the central nervous system. Correctly label each part shown. Then in the spaces provided write the main function of each part.

ACTIVITY #2

TITLE: SIMPLE REFLEXES

PURPOSE:

To examine simple reflexes in humans.

OBJECTIVE:

Students should be able to:

1) List examples of simple reflexes.
2) Conduct tests for simple reflexes.
3) Describe the importance of simple reflexes.

MATERIALS:

None

PROCEDURE:

1) Students define the term simple reflex.
2) Have students list examples of simple reflexes - e.g., knee jerk, secretion of tears, jumping at the sound of a loud noise, pulling away from a hot object, blinking eyes when an object is thrown at them.
3) Conduct experiments to test each reflex and have students record results.
4) Have students explain the importance of simple reflexes.

ACTIVITY #3

TITLE: CONDITIONED REFLEXES

PURPOSE:

To examine the formation of conditioned reflexes in humans and animals.

OBJECTIVE:

Students should be able to:

1) Define a conditioned reflex.
2) State examples of conditioned reflexes in both humans and animals.
3) Conduct a test on a conditioned reflex.

MATERIALS:

None

PROCEDURE:

1) Conduct the following experiment to demonstrate conditioning in human behavior.
    a) Stand in the rear of the room so that your students are not facing you.
    b) Ask them to try to follow what you say.
    c) Direct them to mark a tally line on a sheet of paper each time you say **WRITE**!
    d) Use a ruler to tap on the blackboard or on a desk each time you say **WRITE**, so that the two stimuli are associated with the students' response (the drawing of a line of the paper).
    e) After some 20 times of repeating these signals (about two every second) continue to tap with the ruler but stop using the stimulus word **WRITE**.

NOTE: Many students will continue to draw lines at the sound of the tapping. They have been conditioned temporarily so that they draw a line in response to the stimulus (the sound of the tap).

2) Have students give examples of how animals are conditioned to perform useful and entertaining activities - e.g., dogs herding sheep, horses pulling plows or wagons, animals trained to perform tricks.

ACTIVITY #4

TITLE: **HABITS**

PURPOSE:

To examine the development and value of habits in humans.

OBJECTIVE:

Students should be able to:

1) Define the meaning of the term habit.

2) State the value of habits.

3) Demonstrate habits used on a daily basis.

4) List examples of both good and bad personal habits.

MATERIALS:

None

PROCEDURE:

1) Have students write their name normally as many times as possible in 30 seconds. Repeat the process using the opposite hand. Have students explain why they had difficulty writing with the opposite hand.

2) Direct students to copy as quickly as possible the following paragraph without crossing any T or I words they write.

"Habits are acquired, automatic acts. A habit is formed by first learning an act and then repeating it over and over again in a fixed order. In first learning how to do something, the cerebrum - which is the seat of learning - is involved. After repeated practice the act becomes habitual, and thought is not required. Some common habits are writing, speaking, typing, dancing, driving a car, brushing the teeth, obeying traffic lights."

NOTE: Point out to students the two values of good or useful habits:

A - A person can do more than one thing at a time. When an act has become automatic, thought is no longer required.

B - A person gains greater efficiency and saves time. When an act has been repeated over and over again, this act can be performed more efficiently and more rapidly.

ACTIVITY #5

TITLE: COMPARING THE RATE OF LEARNING

PURPOSE:

To demonstrate that learning occurs when the material studied makes sense and has meaning.

OBJECTIVE:

Students should be able to:

1) Explain the need for understanding main ideas when studying.
2) State the importance of making sense out of all class assignments rather than just memorizing.

MATERIALS:

None

PROCEDURE:

1) On a transparency list in two vertical columns the words in Column A and in Column B.
2) Cover the lists so that students cannot see them.

COLUMN A	COLUMN B
Thing	Its
Whatever	A
As	Very
Odd	Odd
Eats	Thing
Its	As
Very	Odd
Miss T	As
Can	Can
Miss T	Be
Odd	That
As	Whatever
Be	Miss T
Turns	Eats
That	Turns
Into	Into
A	Miss T

3) Uncover the list of words in Column A.

4) Direct students to memorize the list in vertical order.

5) Record the time (It may take 5 to 10 minutes depending on the ability of individual students).

6) Ask students to raise their hand when they have memorized the list. Have them turn away and repeat it.

7) Allow this activity to go on for 5 minutes or more

8) Uncover Column B and have students memorize it.

   A - Keep a record of the time and the number of students who quickly raise their hands when they have memorized the words.

   B - Select the first one, have the student turn away and repeat the words.

   QUESTION: WHY WAS IT EASIER TO LEARN COLUMN "B" THAN COLUMN "A"?

      a) Because Column B had meaning in that the same words had something to say whereas Column A was meaningless (sense and nonsense).

NOTE: Explain to students the need for understanding main ideas so that most work and reading in school does not fit into the category of "nonsense". Explain the need to make sense out of their studying - not just to memorize a list of words or sentences (this is nonsense), real learning takes place when they themselves make sense out of their study work.

ACTIVITY #6

TITLE: LEARNING BY TRIAL AND ERROR

PURPOSE:

To examine the process of trial and error learning.

OBJECTIVE:

Students should be able to:

1) Describe the process of trial and error learning.

2) Give examples of how they have learned by the trial and error method.

3) Explain why trial and error learning is not a beneficial way to learn new information.

MATERIALS:

Master #VII-2

PROCEDURE:

1) Reproduce student copies of Master #VII-2.

2) Instruct students to cut out the four identical figures at the top of the paper (do not cut black line out).

3) Direct students to stack figures so they are all exactly aligned and place them on desk.

4) Instruct students that they will have 10 minutes to arrange the four figures into a perfect square (no hole in center).

    a) Have students raise hand when completed and record time.

    b) Check student puzzle and then restack and wait for class to finish.
    *DO NOT TRY PUZZLE AGAIN!

    c) Repeat above procedure a second time and record results.

d) Have students who were successful a second time teach others how to solve puzzle.

e) Repeat puzzle solution a third time.

f) Have students answer the following questions:

- Why did most students have difficulty in solving the puzzle?

  NOTE: The attempt to put the puzzle together was hit or miss learning called TRIAL AND ERROR LEARNING. This is one of the most time consuming ways to learn new information.

- Why did some students who successfully completed the puzzle the first time fail to complete it in the second trial?

  NOTE: The students succeeded the first time by pure chance (trial and error). The students did not really learn how to solve the puzzle because they did not apply any real meaning to the puzzle. When something has meaning, learning occurs faster.

- Why did many more students complete the puzzle after having the solution demonstrated?

  NOTE: They had been taught to apply meaning to each piece of the puzzle (the position of each card), thus eliminating trial and error.

5) Conduct a second trial and error demonstration using the five remaining figures.

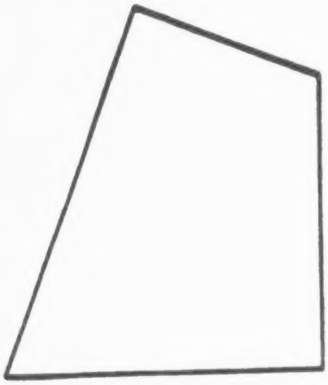
   a) Instruct students to form a "T" with the five figures in the same 10-minute trial period.

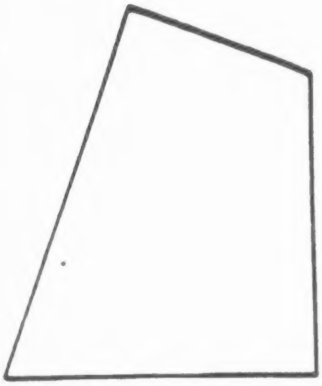
   b) Direct students to follow same procedure as before.

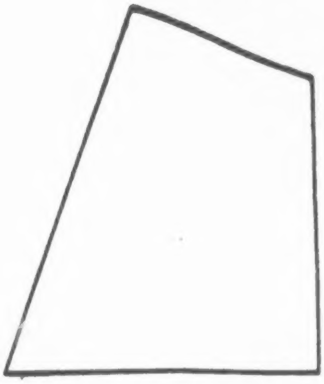
   c) Compare the results of the two experiments.

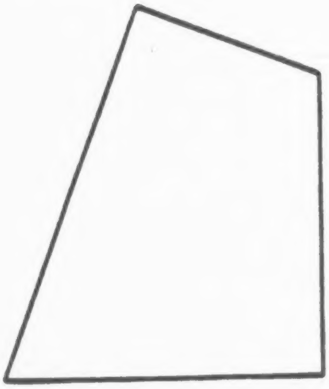
NOTE: Why was the "T" puzzle easier to learn than the "square" puzzle? (The shapes had more meaning and allowed students to figure out a solution rather than use mere trial and error.

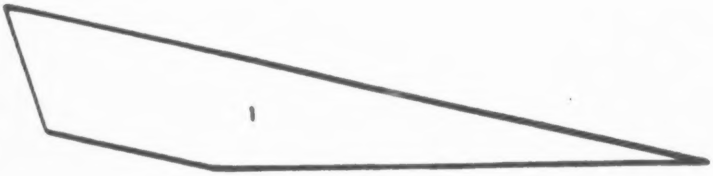
MASTER 8VII-2

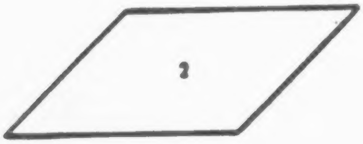


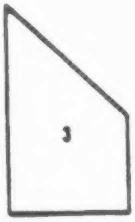


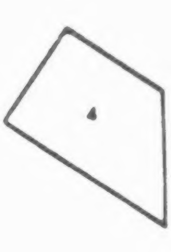


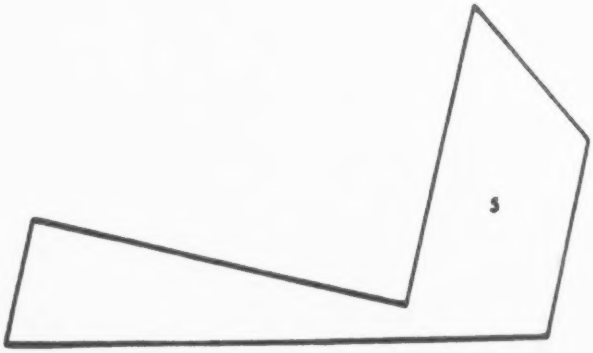












ACTIVITY #7

TITLE: IMPROVING MEMORY

PURPOSE:

To demonstrate a method that can be utilized to improve short term and long term memory.

OBJECTIVE:

Students should be able to:

1) Conduct an experiment to test short term memory.

2) Describe a method that can improve the ability to retain and recall information presented in the classroom.

3) Explain the difference between short term and long term memory.

MATERIALS:

Master #VII-3

PROCEDURE:

ACTIVITY #7A (SHAPE IDENTIFICATION)

1) Prepare transparency of Master #VII-3.

2) Have students place a clean piece of paper and a pen or pencil on desk in front of them.

3) Instruct students that a picture will be flashed on the screen for two seconds and they are to observe it and then attempt to draw what they observed. Tell students that they cannot talk or look at another student's drawing.

4) Have students draw their diagrams on the chalkboard. Draw as many different diagrams as needed until every student feels the diagram he observed has been drawn on board.

5) Repeat step #3 and ask students to again draw what they observed.

NOTE: Ask how many students observed a different diagram. Take a class vote for each diagram drawn on chalkboard.

6) Have students suggest one word to describe each diagram on the chalkboard. Tell students to look for one of the images described on chalkboard.

7) Flash the diagram once more and have students draw a third diagram of their observation.

Question - Did the use of word description improve the recall of the image observed? Take a class count and determine how many students reproduced image correctly after word associated was used.

ACTIVITY #7B (SCENE IDENTIFICATION)

1) Obtain a picture of an outdoor scene in which a flag is flying opposite to the direction in which the smoke from a cchimney is blowing. Also add shadows of objects that make it appear as though the sun were in two places at the same time.

2) Instruct the students that a scene will be flashed on the screen for three seconds and they are to attempt to draw what they observed. Tell students that they cannot talk or refer to another student's drawing.

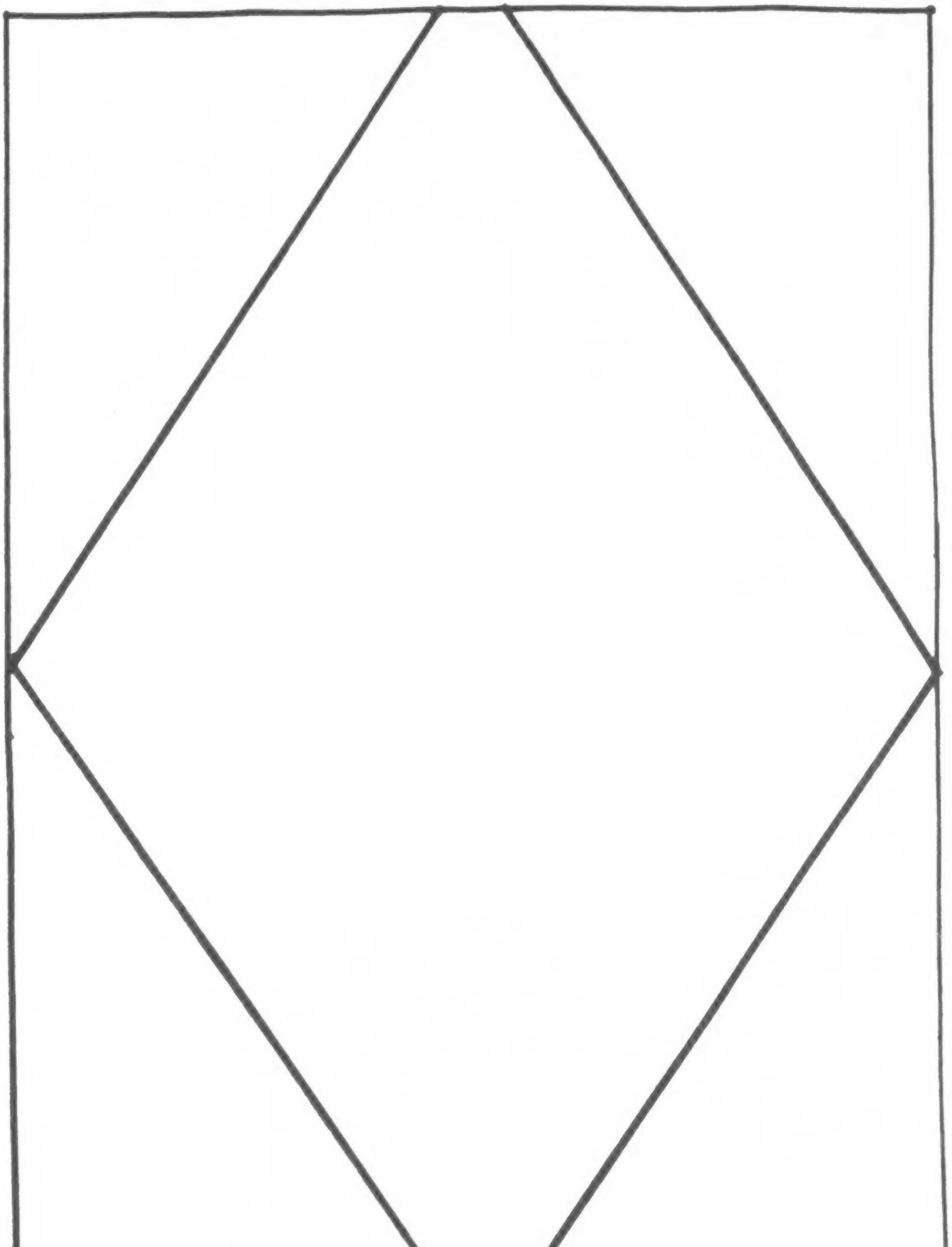
3) Divide the class into two groups.

   - Direct one group to sit in back of the classroom and tell them not to discuss the picture with each other (this is the CONTROL group).

   - Direct the experimental group to discuss the picture and draw a second diagram.

4) Bring both groups together and have the entire class view the scene. Instruct each group to examine the picture and check and accuracy of the details in their drawings.

NOTE: Discuss with students the importance of verbal or written clues to recall details that were observed but omitted from original drawing even though the brain had recorded the entire scene. Relate to students the importance of writing notes and verbalizing while studying as a means of recalling information.



Unit VIII

Air Pollution.

ACTIVITY #1

TITLE: RESEARCH ON ENVIRONMENTAL CONCERNS

PURPOSE: To research environmental problems and prepare a position paper.

OBJECTIVE: Students should be able to:

1) Conduct library research on selected environmental problems.

2) Prepare a position paper on the environmental problem.

MATERIAL:

Library resources (Air Pollution)
Master #VIII-1.

PROCEDURE: See Master #VIII-1.

LIBRARY RESEARCH -ENVIRONMENTAL CONCERNS

1) Select one area of environment concern from the list found below.

2) Discuss in a written report of 3-4 pages the following:

   A - What is the cause of the environment concern?

   B - What is the impact of the environmental concern on humans, animals, plants and property?

C - What are proposed solutions to the environmental concern?

D - What is your position on the environment concern and what course of action would you take as a concerned citizen?

3) Using appropriate bibliographical format, list all references.

SUGGESTED ENVIRONMENTAL CONCERN TOPICS

1. AIR POLLUTION
2. WATER POLLUTIOIN
3. NOISE POLLUTION
4. ACID RAIN
5. NUCLEAR WASTE
6. THERMAL POLLUTION
7. SEWAGE TREATMENT AND DISPOSAL
8. LAND FILLS
9. RECYCLING WASTES
10. ILLEGAL DUMPING
11. LOCAL POLLUTION PROBLEMS/CONCERNS

Contemporary Science
Research Report
Environmental Concerns

Procedure:

1) Select one area of environmental concern from the list found below.

2) Discuss in a written report of 3-4 pages the following:

A - What is the cause of the environmental concern?
B - What is the impact of the environmental concern on humans, animals, plants and property?
C - What are proposed solutions to the environmental concern?
D - What is your position on the environmental concern and what cause of action would you take as a concerned citizen?

3) Using appropriate bibliographical format, list all references.

Suggested Environmental Concern Topics.

1) Air Pollution
2) Water Pollution
3) Noise Pollution
4) Acid Rain
5) Nuclear Waste
6) Thermal Pollution
7) Sewage Treatment and Disposal
8) Landfills
9) Recycling Wastes
10) Illegal Dumping
11) Local Pollution Problems

ACTIVITY #2

TITLE: THE ATMOSPHERE AND BIOGEOCHEMICAL CYCLES

PURPOSE:

To examine the earth's atmosphere and the natural biochemical cycles of the major components present.

OBJECTIVE:

Students should be able to:

1) Diagram and list characteristics of the earth's atmospheric regions.

2) Diagram the natural biogeochemical cycling of the following materials: carbon, oxygen, nitrogen. Each diagram must include the components and their relationship.

NOTE: Hydrologic cycle will be examined in Unit IX - Water Pollution. However, if the teacher wishes it can be introduced at this time.

MATERIALS:

Library resources (atmosphere and biogeochemical cycles)
oaktag paper
colored pencils

PROCEDURE:

NOTE: Divide students into small groups and assign each group the task of diagraming the atmosphere or one of the biogeochemical cycles.

1) Have each group complete assigned diagram on oaktag.

2) Allow student groups to present oral report to class explaining assigned diagram.

3) Conduct class discussion on diagrams using the following guide questions:

ATMOSPHERE

a) What problems would occur if our atmosphere were 100% oxygen?

b) Locate and describe the importance of ozone in our atmosphere.

c) What impact will depletion of the ozone layer have on life on earth?

d) Why are weather systems confined mainly to the atmosphere?

e) Describe the ways we use each of the atmospheric regions.

CARBON CYCLE

a) What form of carbon may be used by the plants to produce carbohydrates?

b) List the ways carbon is returned to the environment from living things?

c) Is any carbon used up in this cycle? If so, where? If not, why not?

d) How many activities of man involve the carbon cycle? Explain the possible effects of at least one of these activities on the normal function of the carbon cycle.

OXYGEN CYCLE

a) Identify and describe the many processes that use oxygen and how it is used.

b) Is it possible that the amount of oxygen in a system could be reduced or exhausted? Explain.

c) What conditions exist that may be disruptive to the oxygen cycle? Remember to consider the fact that the oxygen cycle is dependent on many other cycles.

NITROGEN CYCLE

a) Identify the various components and nitrogen compounds that link the components of the cycle together.

b) Is it possible to remove any of these links without disrupting the cycle? Explain.

c) What conditions are humans creating that disrupt the nitrogen cycle? How could these disruptive conditions be avoided or improved?

d) How does the fact that nitrogen can be lost to ocean sediments relate to soil erosion and to the total amount of nitrogen in terrestrial systems?

ACTIVITY #3

TITLE: TEMPERATURE INVERSION

PURPOSE:

To make a closed system - temperature inversion and study gas diffusion.

OBJECTIVE:

Students should be able to:

1) Construct a closed system temperature inversion.

2) Draw diagrams of normal air circulation and air circulation during temperature inversion.

MATERIALS:

Three 600 ml beakers
200 ml crushed ice
HCl
NH4OH
10 mm glass tube
cotton wads

PROCEDURE:

TEMPERATURE INVERSION LAB

A temperature inversion results when the temperature in the upper atmosphere becomes hotter than the air at ground level. You will accomplish this in the following manner:

1) Place 200 ml of water in a 600 ml beaker and heat on the hot plate to 40-50 C. This is between warm and hot.

2) Place 200 ml of crushed ice in a 600 ml beaker.

These two beakers will represent the hot or cold source for this experiment.

3) The reaction chamber is a 600 ml in which one drop of HCL is placed inside on one side and one drop of NH_4OH is placed inside on the other side. This will produce a smoke of NH_4Cl (ammonium chloride).

4) Immediately place the beaker with crushed ice on top of the reaction chamber and observe the circulation of the smoke using a light behind the beaker to help in the observation. You should see a swirling of the smoke rising from the warm bottom cooling at the cold top and then falling back down to the bottom. This represents a normal air circulation in the earth's atmosphere which will disperse ground pollution by mixing it in the upper atmosphere.

5) Remove the beaker of ice and place the beaker of hot water on top of the reaction chamber. Observe the motion of the smoke in the chamber. You should see the swirling motion slow down and finally stop. This is the situation when a temperature inversion occurs. Because the surface air cannot mix with the upper atmosphere the pollutants are concentrated at the surface.

   a) Draw a picture of the air currents observed in normal circulation.

   b) Draw a picture which shows the density gradient of the smoke in a temperature inversion.

   c) Can you suggest a reason for the wind blowing from the ocean to the land?

DIFFUSION

Diffusion of gases can result in the dispersion of pollutants into the atmosphere. The rate of diffusion of a gas is a function of its molecular weight; the heavier the molecular the slower it moves, the lighter the molecule the faster it moves.

An experiment which demonstrates diffusion can be set up as follows:

1) Clamp a long, 10 mm glass tube in a horizontal position. Insert a small plug of cotton in each end. Simultaneously place 2 drops of HCl (hydrochloric acid) on the cotton on one end and 2 drops of NH_4OH (ammonium hydroxide) on the cotton on the other end.

2) You should observe, after a few minutes, a white precipitate form in the tube. The position the white precipitate will be a function of the rate of the diffusion of the two gases, HCl and NH_3. This rate depends on the molecular weight of the ga which can be determined by adding up the atomic weights. The atomic weight of H is 1.00, Cl is 35.5, and N is 14.0.

   a) Which gas diffused further in the tube? Measure the distance from either end of the tube to the white precipitate.

      HCl to precipitate ____________
      NH_3 to precipitate ____________

   b) What is the molecular weight of each gas?

      HCl _____ NH_3 _____

   c) Based on molecular weight which gas should diffuse faster?

   d) If the average molecular weight of air is 29.4, would NH_3 or HCl diffuse faster than air?

   e) How does diffusion aid in dispersing air pollutants?

ACTIVITY #4

TITLE:

TESTING FOR PARTICULATES IN AIR

PURPOSE:

To examine particulates present in the local environment.

OBJECTIVE:

Students should be able to:

1) Collect particulates in the local environment.
2) Observe and describe the types of particulates present in the air they breathe.
3) State the source of local particulates.
4) Describe the impact of particulates on humans, plants, animals and property.

MATERIALS:

Filter paper
Balance or laboratory scales
Glass jar or beaker
Distilled water
Magnifying glass
Tape and thumb tacks
pH tester - litmus paper (or
Universal pH indicator paper)
Petri dishes

PROCEDURE:

1) Record the weight of each piece of filter paper you plan to use.
2) Select one or more exposure sites for the filter paper; any place where dust collects will do. Weigh any tape used to secure the filter paper at the exposure site.
3) After 3 to 7 days weigh the filter paper again. Note any increase in weight or change in color of the paper.

4) Use the magnifying glass to note the particles collected on the filter paper.

5) Put some distilled water in a beaker or jar. Test the pH of the water and save the litmus paper.

6) Rinse the particles off the filter paper into the beaker and observe the particles with a magnifying glass.

7) Test the pH of the water with the particles suspended in the water. Compare the litmus paper to that used to test the distilled water in Item 5. Save both litmus papers.

8) Obtain a sample of particulate from a source such as an air conditioner or furnace filter. Rinse the particles into another beaker of distilled water. Observe what happens to the particles, check the pH, and compare the litmus papers.

DISCUSSION QUESTIONS

1) Did you find evidence of air pollution particulates in your own environment?

2) Did you find that in a short time a significant buildup of particles can occur.

3) Do particulates differ in size, shape, and color?

4) Although particulates remain suspended in the atmosphere, do they differ in density and solubility?

5) Does particulate matter from a home filter hold acid chemical compounds which will dissolve in water.

6) What possible sources of the particulates collected.

7) Discuss possible affects on humans, plants, animals and property.

ACTIVITY #5

TITLE: GOVERNMENT, THE CITIZEN, AND THE ENVIRONMENT

PURPOSE: To examine how the federal, state and local government agencies deal with environmental problems.

OBJECTIVE: Students should be able to:

1) Recognize and describe how different levels of Government, as well as private and citizen's groups deal with the following problems of environment: pollution, radiation, population, land use, resources, transportation, water, and power.

MATERIALS: None

PROCEDURE:

1) In order to recognize the relationship of the Federal Government to the problems of environment identify by name--and describe their principle activities--of any three of those major Federal agencies which deal with one or more of the following environmental themes: pollution, radiation, population, land use, resources, transportation, agriculture, water, and power.

2) In order to recognize the relationship of State Government to the problems of environment, identify by name--and describe their principle activities--of any three of those major State agencies which deal with one or more of the following encironmental themes: pollution, radiation, population, land use, resources, transportation, agriculture, water, and power.

3) In order to recognize the relationship of private enterprise and citizens' organizations to the activities of State and Federal Government in dealing with the problems of environment, identify by name--and describe their principle activities--of any three of those organizations which relate to governmental activity in the following environmental themes: pollution, radiation, population, land use, resources, transportation, agriculture, water and power.

Unit IX

Water Pollution.

ACTIVITY #1

TITLE: THE EARTH'S HYDROLOGIC CYCLE

PURPOSE:

To examine the earth's water cycle

OBJECTIVE:

Students should be able to:

1) Describe the source of water for all living organisms.

2) Trace the path of water throughout the hydrologic cycle.

3) Describe the impact of human activities on the hydrologic cycle.

MATERIALS:

Master #IX-1.

PROCEDURE:

1) Prepare a transparency and student copies of Master #IX-1.

2) Instruct students to use diagram of hydrologic cycle to answer the following questions:

    a) Beginning with the ocean, state briefly where the ocean water goes, in what form(s), and how it is utilized by living organisms including man.

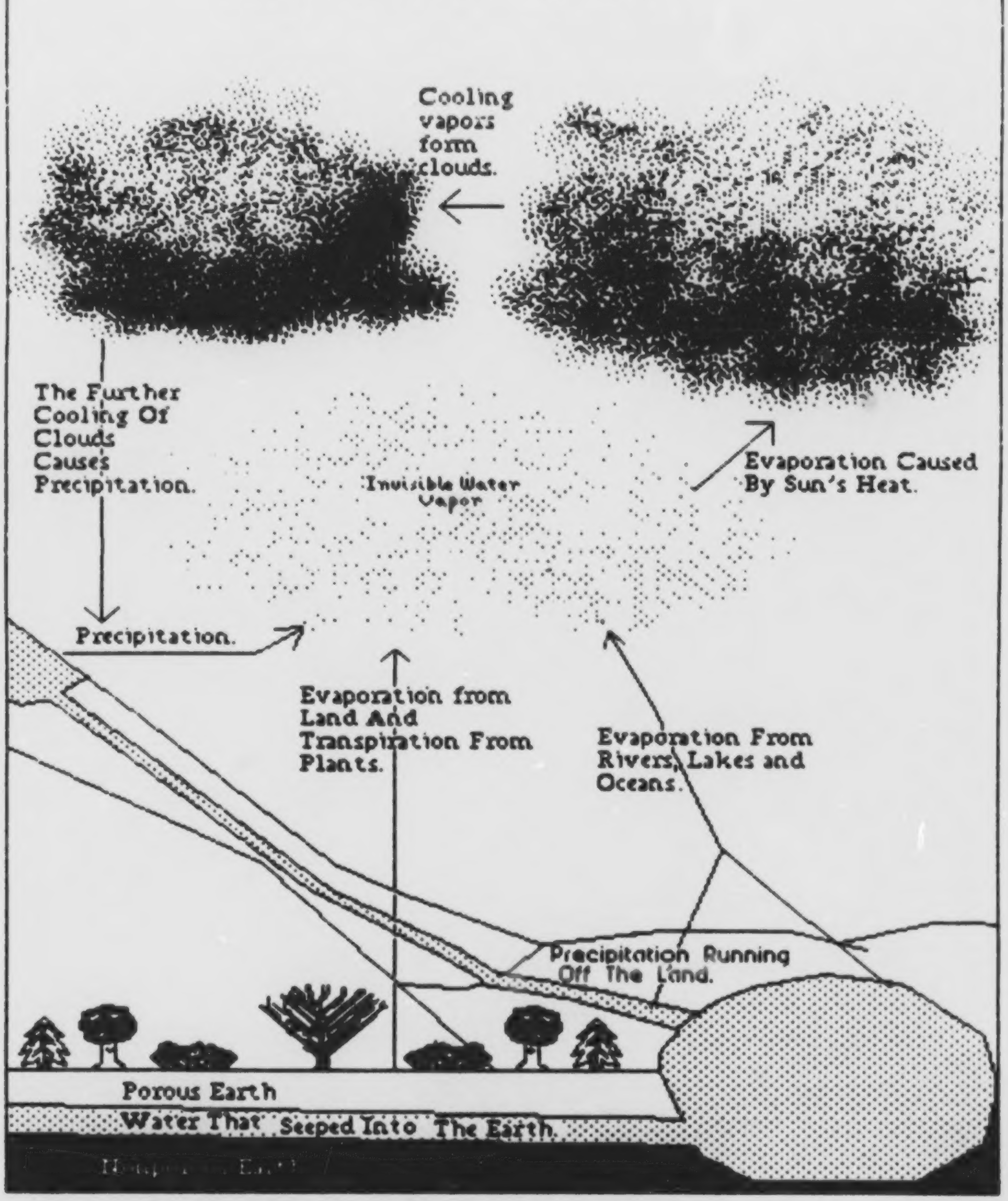
b) What is the energy source which powers the water cycle? What form does this energy take (light, heat, electricity, etc.) in various parts of the cycle?

c) Water is cycled over and over. What becomes of the energy which powers the cycle?

d) PROBLEM: The farmer on the hill sprays his crops with a pesticide. How does this affect the water cycle? How does it affect other areas that are part of the water cycle?

e) Identify and trace the affects of another man made condition on the water cycle (i.e., deforestration, industrial waste, exhausting the deep storage water, paving the surface of fields).

The Water Cycle.


Cooling vapors form clouds.
The Further Cooling Of Clouds Causes Precipitation.
Invisible Water Vapor
Evaporation Caused By Sun's Heat.
Precipitation.
Evaporation from Land And Transpiration From Plants.
Evaporation From Rivers, Lakes and Oceans.
Precipitation Running Off The Land.
Porous Earth
Water That Seeped Into The Earth.
Nonporous Earth

ACTIVITY #2

TITLE: UNDERGROUND WATER RESERVOIRS

PURPOSE:

To examine the source, utilization and contamination of a major portion of the country's drinking water.

OBJECTIVE:

Students should be able to:

1) Trace the path of drinking water from its source to its use in the home.

2) Describe how water is used on a daily basis.

3) List ways that the local water supply could become contaminated.

4) State various water conservation measures that could be undertaken to save water.

MATERIALS:

Master #IX-2.

PROCEDURE:

ACTIVITY #2A (PATH OF DRINKING WATER)

1) Prepare a transparency and student copies of Master #IX-2.

2) Have students answer the following guide questions:

   a) What is the water table?

   b) What is an aquifer?

   c) Where does the water in the aquifer come from?

   d) What are three other sources of drinking water in our country? (Reservoirs, streams and lakes).

ACTIVITY #2B (DAILY WATER USEAGE)

1) Divide class into small groups.

2) Have each group list water useage by the following sectors of society: residential, industrial, commercial, public.

3) Have students describe the impact of water loss to each of these sectors of society.

ACTIVITY #2C (WATER CONTAMINATION)

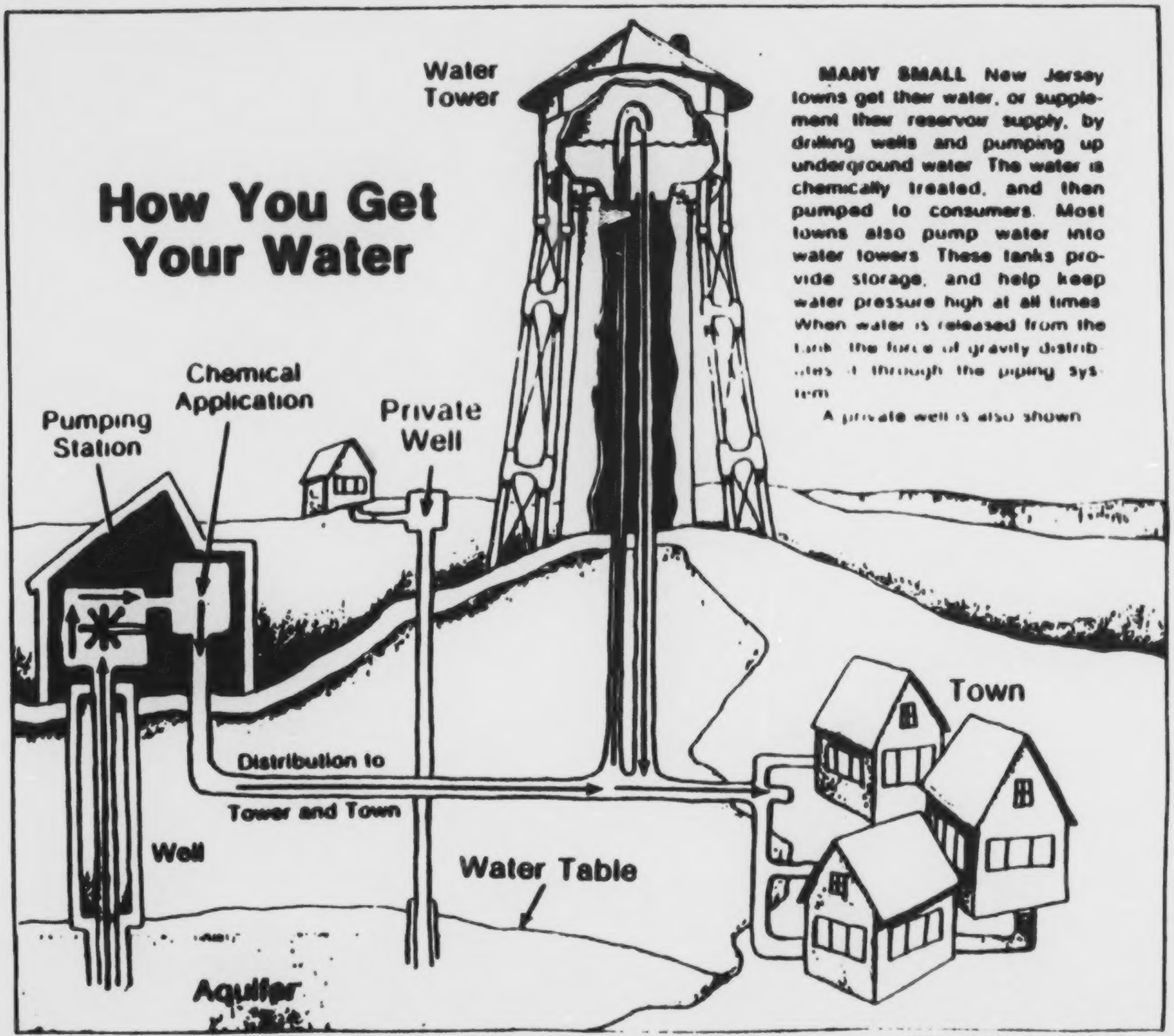
1) Have students list possible sources of water supply contamination (i.e., underground gasoline storage tanks, road salt, pesticides, hazardous waste sites).

2) Have students describe local incidents of water supply contamination.

3) Ask for student solutions for prevention of water contamination and actions that should be taken when violators are identified.

ACTIVITY #2D (WATER CONSERVATION)

1) Have students list ways they can reduce personal water useage (i.e., reduce toilet flow, shorter showers, reduced flow showerheads, clean driveway with broom instead of a hose).



How You Get Your Water

MANY SMALL New Jersey towns get their water, or supplement their reservoir supply, by drilling wells and pumping up underground water. The water is chemically treated, and then pumped to consumers. Most towns also pump water into water towers. These tanks provide storage, and help keep water pressure high at all times. When water is released from the tank, the force of gravity distributes it through the piping system.

A private well is also shown.

Water Tower
Chemical Application
Pumping Station
Private Well
Distribution to Tower and Town
Town
Well
Water Table
Aquifer

PRENDIMANO - Asbury Park Press

ACTIVITY #3

TITLE: WATER POLLUTION CLASSIFICATION

PURPOSE:

To familiarize students with the classification and terminology of water pollutants.

OBJECTIVE:

Students should be able to:

1) List the eight categories of water pollution.
2) Define and identify the pollutants in each of the eight categories.

MATERIALS:

Background information sheet

PROCEDURE:

1) List the eight categories of classification on chalkboard.
2) Describe the meaning of each category.
3) Have students provide examples of pollutants for each category with teacher assistance.

MASTER SIX-3

BACKGROUND INFORMATION: WATER POLLUTION CLASSIFICATION

POLLUTION IS GENERALLY DEFINED AS THE RESULT OF SUBSTANCES INTRODUCED INTO THE ENVIRONMENT BY HUMAN ACTIVITIES WHICH ARE DETRIMENTAL TO PLANTS AND ANIMALS.

In the most simple classification, pollution may be divided into eight categories:

(1) **NUTRIENTS**--dissolved inorganic elements and compounds which increase photosynthetic activity. Sewage is among the most common nutrient sources.

(2) **OXYGEN CONSUMING MATERIALS**--chemical and biological additions which remove dissolved oxygen from the water. Examples are sewage and organic matter.

(3) **PARTICULATE MATTER**--finely dissolved particles which remain in the water column for long periods of time. Their eventual settlement may have detrimental effects on benthic organisms. Examples are silts from dredging, or erosion, or particulate matter from industrial discharges.

(4) **TOXIC SUBSTANCES**--chemicals that cause death or which block or slow down physiological processes. These include thousands of biocides and toxic materials from human activities such as industrial outfalls, non-point sources, and mine leaching.

(5) **HEAT (THERMAL ENERGY)**--temperature increases in an aquatic environment may cause complex changes Heat can increase biological activity to a certain point beyond which organisms sufferr distress.

(6) **RADIOACTIVE WASTE**--elements and compounds emitting ionizing radiation. Long-term health hazard affecting all living organisms.

(7) **WATER DIVERSIONS**--excess fresh water introduced into an estuary or excess salt added to fresh or brackish water.

(8) **TRASH**--non-degradable refuse. Six million tons per year are dumped in the ocean.

Any of the above primary pollutants may combine to form synergistic substances.

ACTIVITY #4

TITLE: TOXIC WASTES

PURPOSE:

To identify and explain the effects of toxic wastes present in water resources.

OBJECTIVE:

Students should be able to:

1) Conduct library research on toxic wastes.

2) Describe the history, dangers, method of exposure and protective action for each toxic waste.

MATERIALS:

Library resources (Water Pollution)

PROCEDURE:

1) Provide each student with the following list of toxic wastes:

   a) Dioxin
   b) Polychlorinated biphenyls
   c) Radioactive waste
   d) Asbestos
   e) Trichloroethylene
   f) Benzene
   g) Lead
   h) Mercury
   i) Sewage sludge
   j) Other herbicides or pesticides

2) Have the students conduct library research on toxic waste topic assigned.

3) Instruct students to research the following information:

   a) Describe the historical development of the toxic waste.

b) What dangers to humans, plants, animals, and property are posed by the toxic waste?

c) How are hummans, plants, animals, and property exposed or contaminated by the toxic waste?

d) What protective measures can be employed to prevent exposure or contamination by the toxic waste?

ACTIVITY #5

TITLE: SEWAGE TREATMENT PROCESS

PURPOSE:

To examine the method employed to treat human sewage.

OBJECTIVE:

Students should be able to:

1) Diagram the sewage treatment process.
2) Describe the process and effectiveness of each stage of treatment.
3) State the type of sewage treatment used locally.
4) Evaluate the effectiveness of the local sewage treatment facility.
5) Recommend changes to improve (upgrade) local treatment plant and plan for future expansion in the event of a population increase.

MATERIALS:

Master #IX-4

PROCEDURE:

1) Prepare transparency and student copies of Master #IX-4.
2) Trace the steps in the sewage treatment process.
3) Have students write a description of each stage and the process that occurs at each state of treatment.
4) Take a class trip to local treatment plant or have a group of students visit plant and obtain information from plant manager describing the treatment process used.

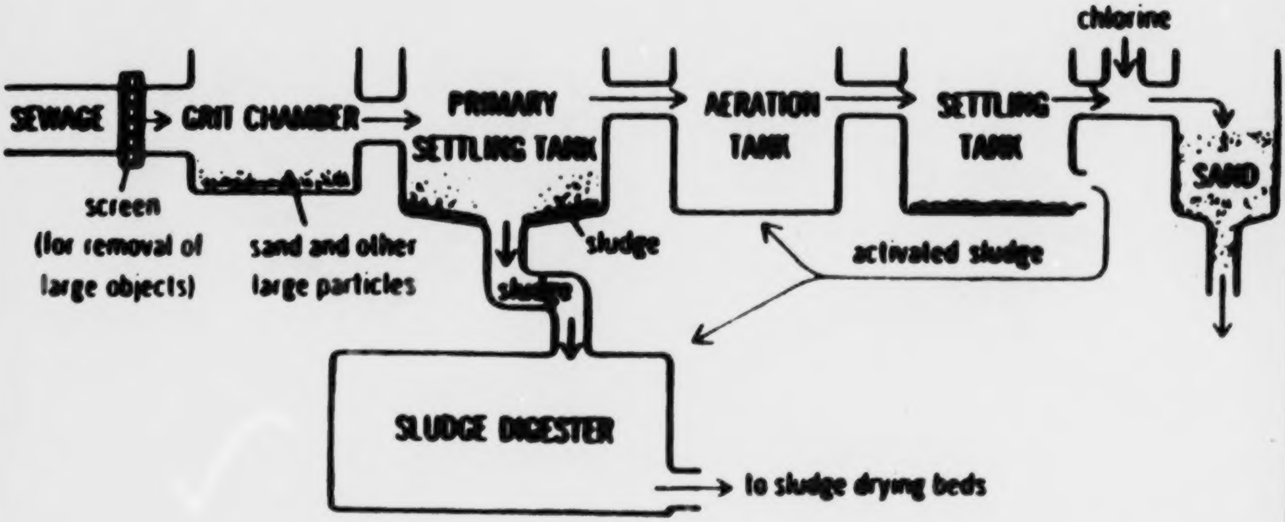
5) Have class examine the information and:

   a) Evaluate the effectiveness of the local sewage treatment facility.

   b) Recommend immediate changes needed to upgrade facility.

   c) Recommend future changes anticipated.

SEWAGE TREATMENT PROCESS


chlorine
SEWAGE
GRIT CHAMBER
PRIMARY SETTLING TANK
AERATION TANK
SETTLING TANK
SAND
screen (for removal of large objects)
sand and other large particles
sludge
sludge
activated sludge
SLUDGE DIGESTER
to sludge drying beds

ACTIVITY #6

TITLE: ACID RAIN

PURPOSE:

To examine how acid rain is produced and the present and future environmental impact.

OBJECTIVE:

Students should be able to:

1) Identify sources of acid rain.
2) Describe and write chemical reactions to explain acid rain formation.
3) Provide examples of the environmental impact of acid rain on humans, plants, animals and property.
4) Locate on U.S. maps the areas impacted by acid rain.
5) Predict future consequences of acid rain.
6) Suggest methods to control or prevent acid rainfall.

MATERIALS:

Masters #IX-5 and #IX-6

PROCEDURE:

1) Prepare transparencies and student copies of Masters #IX-5 and #IX-6.
2) Have students examine acid rain diagram and answer the following questions:
    a) Name the two gases which produce acid rain.
    b) What are two sources of each of the gases that produce acid rain.

c) What are effects of acid rain on humans, plants, animals, and property (obtain information from students who've prepared research reports on acid rain during air pollution unit).

d) What are possible solutions to eliminate acid rain (e.g., industrial scrubbers, limit automotive use in certain areas, alternative energy sources).

3) Have students examine map of eastern U.S. and diagram of pH scale and answer the following questions:

a) Where are the major sources of sulfer-dioxide in the eastern U.S.?

b) What areas are most sensitive to acid rainfall?

c) What is measured by pH scale?

d) What is the range of substances identified as basic (alkaline)?

e) What is the range of substances identified as acidic?

f) What is the pH of neutral substance?

g) Identify two strong bases. pH?

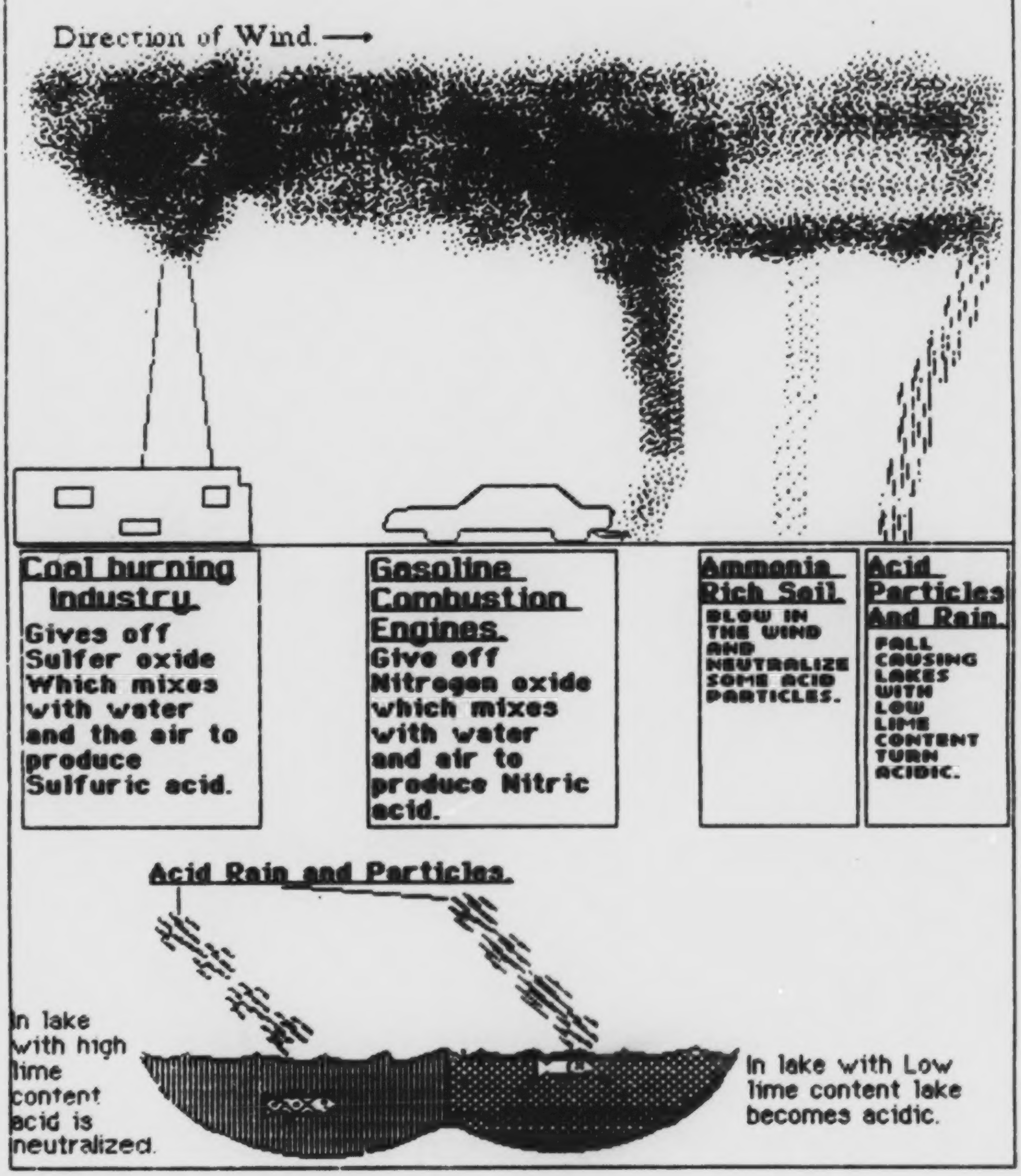
h) Identify two strong acids. pH?

i) What is the pH range of acid rain?

j) What is the pH of normal rainfall?

MASTER #IX-5

Formation Of Acid Rain.



Coal burning Industry.

Gives off Sulfer oxide Which mixes with water and the air to produce Sulfuric acid.

Gasoline Combustion Engines.

Give off Nitrogen oxide which mixes with water and air to produce Nitric acid.

Ammonia Rich Soil.

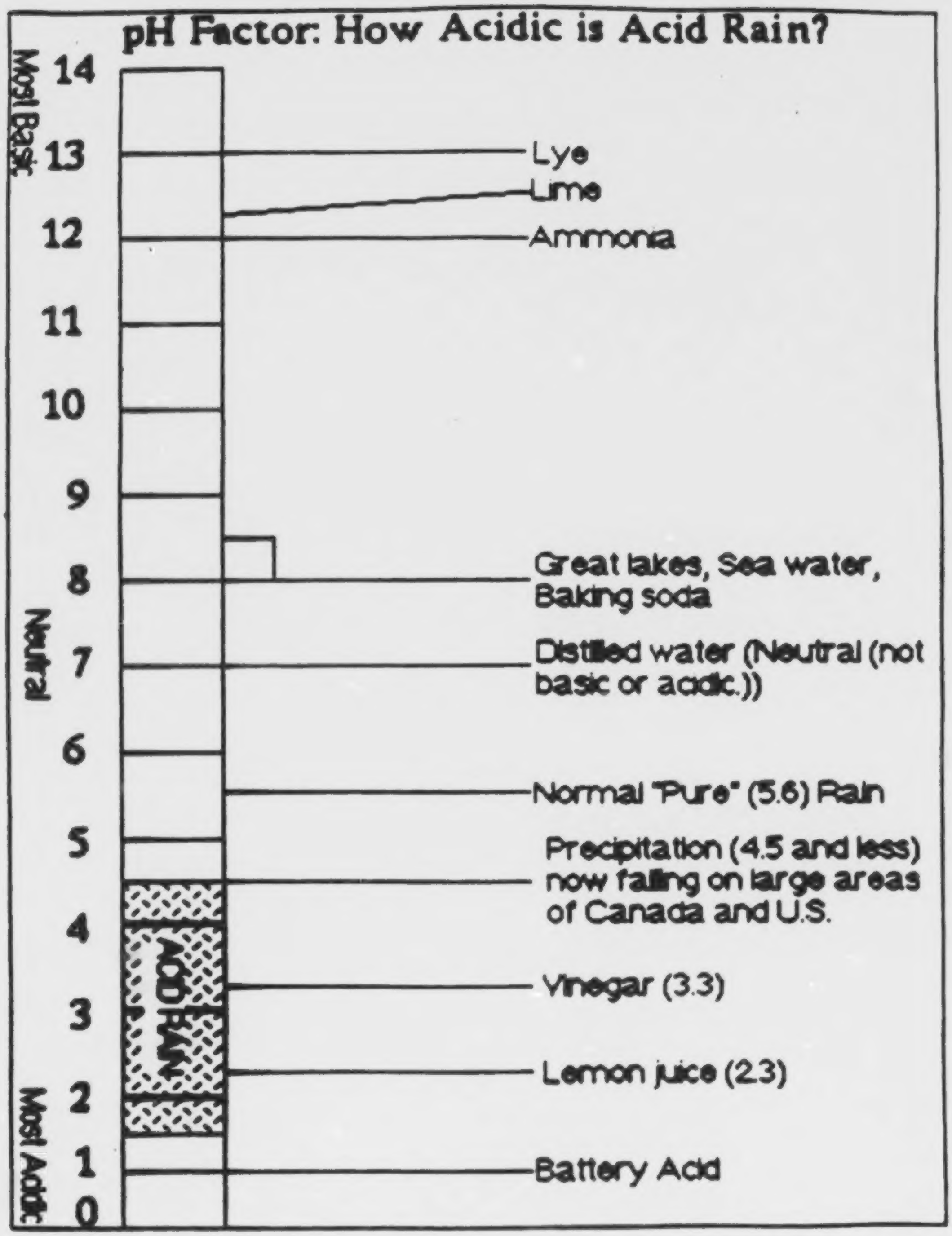
BLOW IN THE WIND AND NEUTRALIZE SOME ACID PARTICLES.

Acid Particles And Rain.

FALL CAUSING LAKES WITH LOW LIME CONTENT TURN ACIDIC.

In lake with high lime content acid is neutralized.

In lake with Low lime content lake becomes acidic.



pH Factor: How Acidic is Acid Rain?

ACTIVITY #7

TITLE: WATER POLLUTION FIELD STUDY

PURPOSE:

To investigate local water bodies for evidence of pollution.

OBJECTIVE:

Students should be able to:

1) Collect water samples from local water resources (e.g., lakes, streams, ponds, reservoirs, ocean).
2) Analyze specific chemical and biological components of water resource.
3) Draw conclusions from data collected as to whether or not water resource is polluted and to what degree.
4) Prescribe action to improve the condition of the water resource.

MATERIALS:

Water test kit
Microscope
pH paper
Glass slides
Cover slips
Screw top vials or bottles
Water samples

Lens paper
Paper towels
Test tube rack
Funnels
Test tubes
Filler paper
Rubber gloves

PROCEDURE:

1) Divide students into small groups and assign (or allow students to select) each group a water resource (e.g., lake, river, stream, pond, ocean) from which they will collect water samples.
2) Have students collect water samples and also TAKE PHOTOGRAPHS or VIDEOTAPE the area where water samples are obtained.

3) Have students observe and report the following water collection site information:

   a) Type of area (e.g., recreational, industrial residential, commercial).

   b) Other sources of water feeding into water collection site.

   c) General appearance (e.g., color, clarity, debris) of collection site.

   d) Evidence of pipes or storm drains leading into collection site.

4) LABORATORY TESTING

   a) NOTE: All lab work MUST be performed with students wearing rubber gloves at all times and goggles when chemical tests are performed.

   b) Instruct students to conduct the following tests on water sample:

      - Color
      - Turbidity (clarity of sample)
      - Odor
      - Oil (presence or absence of)
      - pH
      - Filtration (examine filter paper and filtered water)
      - Test dissolved oxygen (use water test kit)
      - Test phosphate content (also shake and observe for foam)
      - Microscopic examination (types and concentration) of microscopic organisms.

   c) Have each group prepare a final report for presentation to class.

   d) Encourage students to submit reports to the local or county health department if they determine the water resource presents a potential health or environment impact on the community.

   NOTE: The photos, slides, or videos can be used for future comparison studies to demonstrate changes.

ACTIVITY #8

TITLE: GETTING INVOLVED IN ENVIRONMENTAL CONCERNS

PURPOSE:

To make students aware of public hearings/meetings relating to environmental concerns and how they can voice personal concerns on local/county/state environmental issues.

OBJECTIVE:

Students should be able to:

1) Locate the date, time, and location of public hearings/meetings on environmental issues.

2) Research background information pertinent to topic being discussed at hearing/meeting.

3) Pose questions at hearing/meeting to further understand the issues.

4) Conduct a hearing/meeting on environmental issues in school.

MATERIALS:

Local/county newspapers
Library resources

PROCEDURE:

1) Instruct the students to select one environmental topic of current interest listed below and plan to attend a public hearing/meeting to learn more about the issue.

TOPICS

- Hazardous/toxic waste disposal
- Landfills
- Sewage collection and disposal
- Source separation/recycling

2) WHERE'S THE HEARING? - Your municipal or county office can inform you of any forthcoming: 1) Public hearings, 2) Public meetings, or 3) Informational meetings dealing with these topics. You can also find public hearings listed near the classified section of most newspapers. In your own community, plan to attend a planning board or zoning board of adjustment meeting. Try to prepare for any of these meetings by reading the minutes of the previous meeting, news accounts of previous meetings and by getting a copy of the agenda for the next meeting, which may be obtained from the municipal building of your community.

3) GETTING PREPARED: Collect information to have a class discussion on the subject your class chose. This discussion will let you see exactly what you do know and what areas require further researching.

Go to the school or public library. Read as many books or pamphlets on your subject as you can find. Use the Reader's Guide to Periodical Literature and the library card file.

Your public library may have a newspaper file. Look through the copies of old newspapers for any articles about your subject. If you can, make a copy of these articles for a file in your classroom. If not, send a committee of two or three to your nearest local or area newspaper to research the files. It should have a file of clippings called a "morgue."

Contact members of the different organizations as well as town or city officials that will be appearing at the hearing/meeting. Get their views of your subject. Have a class discussion after the information has been gathered by your class.

a) Discuss what aspects of your topic you feel will have more importance at the hearing or what you feel will be discussed.

b) What your class would like to hear discussed at the meeting.

c) A series of questions should be written with questions pertaining to aspects your class wants to know more about or what issues that will discuss.

d) Discuss as a class what you think the outcome of the hearings might me.

4) AT THE HEARING

a) Your whole class is welcome to attend any of the hearings or meetings.

b) Choose 1 or 2 classmates as designated spokespersons if any questions are to be asked by your class.

c) The remainder of the class may take notes.

d) A tape recorder may be of help if permission to operate one during the hearing/meeting is given.

5) BACK IN CLASS - discuss what new information has been gained on your subject after attending a public hearing/meeting.

a) Did the hearing go as you expected?

b) Did you feel the hearing had any significant value?

c) If your class tried to present a differing viewpoint, were your ideas well received?

d) What changes, if any, do you feel will come about because of the public hearing/meeting?

e) A concluding discussion on possible or desirable alternatives is a good ending for your class discussion about the hearing(s).

6) ON YOUR OWN: As a class, you may wish to have a hearing or meeting on the subject(s) of the hearing(s) your class chose to attend. Challenge any other class to participate in a debate on your subject.

Maybe setting up a meeting/hearing at your school would help inform your neighbors about problems dealing with solid waste. If you decide to do this:

a) You will first have to get permission to use the school auditorium.

b) Contact community officials. Find out what problems the community officials think would be beneficial to your neighbors if you were to conduct a meeting at the school.

c) Invite community officials and organizations with differing viewpoints concerning the problem considered at the hearing.

d) Prepare a report which your designated spokesperson will present at the hearing. This report should reflect your class's opinion on the subject chosen.

e) If the subject your class chose for the meeting/hearing in the school is different from the subject discussed in the original public hearing, follow the steps within this lesson to research the new subject.

f) Inform your neighbors and fellow students about the hearing. Make posters and put them up around your school and neighborhood. Display the posters at least 2 weeks before the hearing/meeting.

Unit X
Noise Pollution.

ACTIVITY #1

TITLE: HUMAN EAR

PURPOSE:

To examine the structure and function of the human ear.

OBJECTIVE:

Students should be able to:

1) Identify parts of the human ear.
2) Describe the function of the structures found in the human ear.
3) Trace the path of sound waves through the ear.

MATERIALS:

Diagram or transparency of human ear.

PROCEDURE:

1) Provide students with a diagram of the human ear.
2) Have students label parts of the human ear.
3) Have students explain the function of each part in their notebooks.
4) Describe the path of sound waves through the human ear.
5) Have students identify the parts of the ear most susceptable to damage.

ACTIVITY #2

TITLE: THE MEASUREMENT OF SOUND

PURPOSE:

To examine how sound is measured and understand the sound levels of everyday activities.

OBJECTIVE:

Students should be able to:

1) Observe how a decibel meter detects and measures sound.

2) Construct a decibel scale for selected sounds.

MATERIALS:

Decibel meter
Master #X-1

PROCEDURE:

1) Demonstrate how the decibel meter measures sound.

2) Define the term decibel.

3) Prepare transparency of Master #X-1 and student copies with decibel levels of daily activities omitted (except for location of normal conversations).

4) Have students write the location of daily activities on the chart at the decibel level they estimate the activity would produce.

   NOTE: More than one activity may be placed at the same decibel level on chart.

5) Show students transparency of decibel levels with actual location of activities. Have students check the number of activities they placed correctly on decibel scale.

225

DECIBEL LEVELS

200	Rocket Launching
180	
160	
140	Jetplane, gunshot
130	Pneumatic riveter, Rock band
120	Carhorn, Subway, Thunder
110	Sandblasting, Loud stereo
100	Punch press, outboard
90	Heavy traffic, Blender
80	Average factory, Typewriter
70	Noisy office / restaurant
60	NORMAL CONVERSATION
50	Average home, Quiet street
40	Refrigerator, Private office
30	Soft whisper, Country home
20	Rustling leaves
10	Normal breathing
0	Faintest audible whisper

Hearing loss may occur from long exposure

May cause pain

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NOTE: Many students will continue to draw lines at the sound of the tapping. They have been conditioned temporarily so that they draw a line in response to the stimulus (the sound of the tap).

2) Have students give examples of how animals are conditioned to perform useful and entertaining activities - e.g., dogs herding sheep, horses pulling plows or wagons, animals trained to perform tricks.

ACTIVITY #4

TITLE: HABITS

PURPOSE:

To examine the development and value of habits in humans.

OBJECTIVE:

Students should be able to:

1) Define the meaning of the term habit.

2) State the value of habits.

3) Demonstrate habits used on a daily basis.

4) List examples of both good and bad personal habits.

MATERIALS:

None

PROCEDURE:

1) Have students write their name normally as many times as possible in 30 seconds. Repeat the process using the opposite hand. Have students explain why they had difficulty writing with the opposite hand.

2) Direct students to copy as quickly as possible the following paragraph without crossing any T or I words they write.

"Habits are acquired, automatic acts. A habit is formed by first learning an act and then repeating it over and over again in a fixed order. In first learning how to do something, the cerebrum - which is the seat of learning - is involved. After repeated practice the act becomes habitual, and thought is not required. Some common habits are writing, speaking, typing, dancing, driving a car, brushing the teeth, obeying traffic lights."

NOTE: Point out to students the two values of good or useful habits:

A - A person can do more than one thing at a time. When an act has become automatic, thought is no longer required.

B - A person gains greater efficiency and saves time. When an act has been repeated over and over again, this act can be performed more efficiently and more rapidly.

ACTIVITY #5

TITLE: COMPARING THE RATE OF LEARNING

PURPOSE:

To demonstrate that learning occurs when the material studied makes sense and has meaning.

OBJECTIVE:

Students should be able to:

1) Explain the need for understanding main ideas when studying.

2) State the importance of making sense out of all class assignments rather than just memorizing.

MATERIALS:

None

PROCEDURE:

1) On a transparency list in two vertical columns the words in Column A and in Column B.

2) Cover the lists so that students cannot see them.

COLUMN A	COLUMN B
Thing	Its
Whatever	A
As	Very
Odd	Odd
Eats	Thing
Its	As
Very	Odd
Miss T	As
Can	Can
Miss T	Be
Odd	That
As	Whatever
Be	Miss T
Turns	Eats
That	Turns
Into	Into
A	Miss T

3) Uncover the list of words in Column A.

4) Direct students to memorize the list in vertical order.

5) Record the time (It may take 5 to 10 minutes depending on the ability of individual students).

6) Ask students to raise their hand when they have memorized the list. Have them turn away and repeat it.

7) Allow this activity to go on for 5 minutes or more

8) Uncover Column B and have students memorize it.

   A - Keep a record of the time and the number of students who quickly raise their hands when they have memorized the words.

   B - Select the first one, have the student turn away and repeat the words.

QUESTION: WHY WAS IT EASIER TO LEARN COLUMN "B" THAN COLUMN "A"?

   a) Because Column B had meaning in that the same words had something to say whereas Column A was meaningless (sense and nonsense).

NOTE: Explain to students the need for understanding main ideas so that most work and reading in school does not fit into the category of "nonsense". Explain the need to make sense out of their studying - not just to memorize a list of words or sentences (this is nonsense), real learning takes place when they themselves make sense out of their study work.

ACTIVITY #6

TITLE: LEARNING BY TRIAL AND ERROR

PURPOSE:

To examine the process of trial and error learning.

OBJECTIVE:

Students should be able to:

1) Describe the process of trial and error learning.

2) Give examples of how they have learned by the trial and error method.

3) Explain why trial and error learning is not a beneficial way to learn new information.

MATERIALS:

Master #VII-2

PROCEDURE:

1) Reproduce student copies of Master #VII-2.

2) Instruct students to cut out the four identical figures at the top of the paper (do not cut black line out).

3) Direct students to stack figures so they are all exactly aligned and place them on desk.

4) Instruct students that they will have 10 minutes to arrange the four figures into a perfect square (no hole in center).

   a) Have students raise hand when completed and record time.

   b) Check student puzzle and then restack and wait for class to finish.
   *DO NOT TRY PUZZLE AGAIN!

   c) Repeat above procedure a second time and record results.

d) Have students who were successful a second time teach others how to solve puzzle.

e) Repeat puzzle solution a third time.

f) Have students answer the following questions:

- Why did most students have difficulty in solving the puzzle?

  NOTE: The attempt to put the puzzle together was hit or miss learning called TRIAL AND ERROR LEARNING. This is one of the most time consuming ways to learn new information.

- Why did some students who successfully completed the puzzle the first time fail to complete it in the second trial?

  NOTE: The students succeeded the first time by pure chance (trial and error). The students did not really learn how to solve the puzzle because they did not apply any real meaning to the puzzle. When something has meaning, learning occurs faster.

- Why did many more students complete the puzzle after having the solution demonstrated?

  NOTE: They had been taught to apply meaning to each piece of the puzzle (the position of each card), thus eliminating trial and error.

5) Conduct a second trial and error demonstration using the five remaining figures.

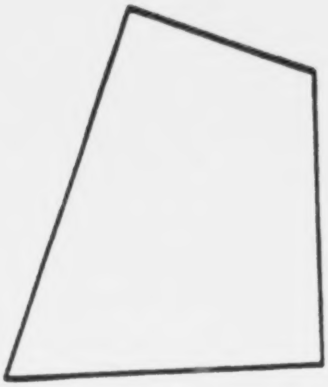
   a) Instruct students to form a "T" with the five figures in the same 10-minute trial period.

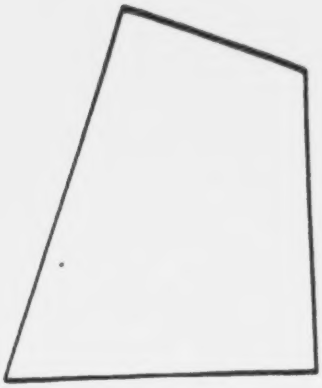
   b) Direct students to follow same procedure as before.

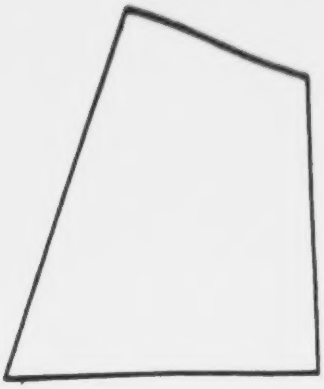
   c) Compare the results of the two experiments.

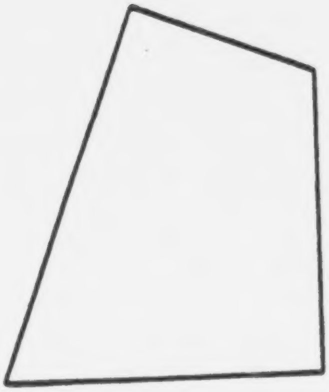
NOTE: Why was the "T" puzzle easier to learn than the "square" puzzle? (The shapes had more meaning and allowed students to figure out a solution rather than use mere trial and error.

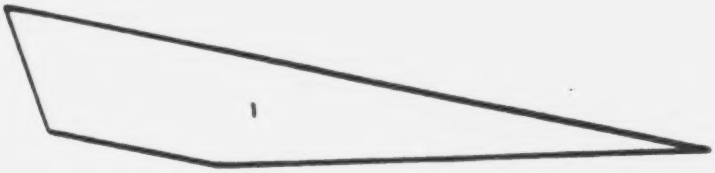
MASTER 8VII-2

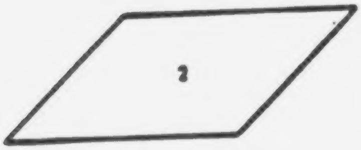


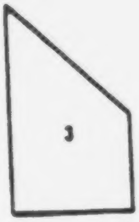


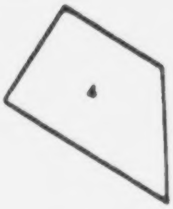


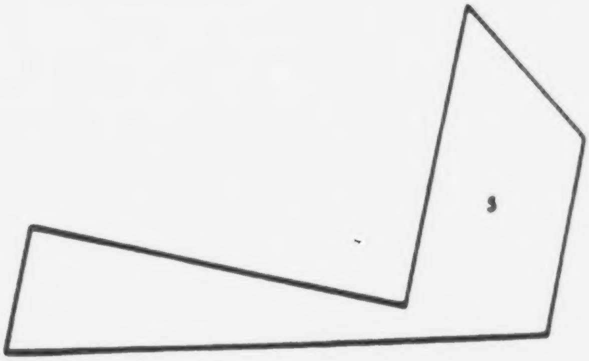












ACTIVITY #7

TITLE: IMPROVING MEMORY

PURPOSE:

To demonstrate a method that can be utilized to improve short term and long term memory.

OBJECTIVE:

Students should be able to:

1) Conduct an experiment to test short term memory.

2) Describe a method that can improve the ability to retain and recall information presented in the classroom.

3) Explain the difference between short term and long term memory.

MATERIALS:

Master #VII-3

PROCEDURE:

ACTIVITY #7A (SHAPE IDENTIFICATION)

1) Prepare transparency of Master #VII-3.

2) Have students place a clean piece of paper and a pen or pencil on desk in front of them.

3) Instruct students that a picture will be flashed on the screen for two seconds and they are to observe it and then attempt to draw what they observed. Tell students that they cannot talk or look at another student's drawing.

4) Have students draw their diagrams on the chalkboard. Draw as many different diagrams as needed until every student feels the diagram he observed has been drawn on board.

5) Repeat step #3 and ask students to again draw what they observed.

NOTE: Ask how many students observed a different diagram. Take a class vote for each diagram drawn on chalkboard.

6) Have students suggest one word to describe each diagram on the chalkboard. Tell students to look for one of the images described on chalkboard.

7) Flash the diagram once more and have students draw a third diagram of their observation.

Question - Did the use of word description improve the recall of the image observed? Take a class count and determine how many students reproduced image correctly after word associated was used.

ACTIVITY #7B (SCENE IDENTIFICATION)

1) Obtain a picture of an outdoor scene in which a flag is flying opposite to the direction in which the smoke from a cchimney is blowing. Also add shadows of objects that make it appear as though the sun were in two places at the same time.

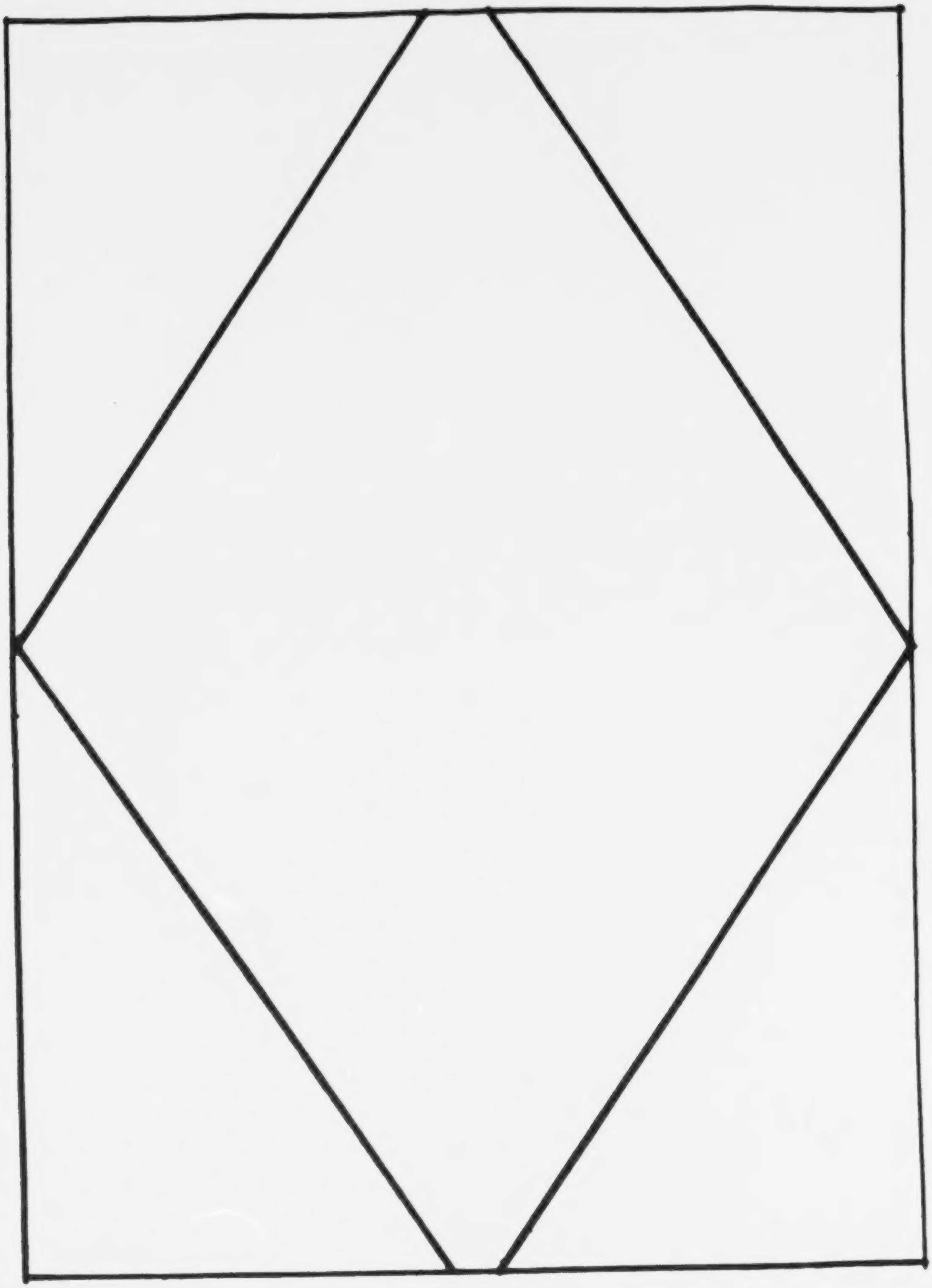
2) Instruct the students that a scene will be flashed on the screen for three seconds and they are to attempt to draw what they observed. Tell students that they cannot talk or refer to another student's drawing.

3) Divide the class into two groups.

- Direct one group to sit in back of the classroom and tell them not to discuss the picture with each other (this is the CONTROL group).
- Direct the experimental group to discuss the picture and draw a second diagram.

4) Bring both groups together and have the entire class view the scene. Instruct each group to examine the picture and check and accuracy of the details in their drawings.

NOTE: Discuss with students the importance of verbal or written clues to recall details that were observed but omitted from original drawing even though the brain had recorded the entire scene. Relate to students the importance of writing notes and verbalizing while studying as a means of recalling information.



Unit VIII
Air Pollution

ACTIVITY #1

TITLE: RESEARCH ON ENVIRONMENTAL CONCERNS

PURPOSE:

To research environmental problems and prepare a position paper.

OBJECTIVE:

Students should be able to:

1) Conduct library research on selected environmental problems.

2) Prepare a position paper on the environmental problem.

MATERIAL:

Library resources (Air Pollution)
Master #VIII-1.

PROCEDURE:

See Master #VIII-1.

LIBRARY RESEARCH -ENVIRONMENTAL CONCERNS

1) Select one area of environment concern from the list found below.

2) Discuss in a written report of 3-4 pages the following:

   A - What is the cause of the environment concern?

   B - What is the impact of the environmental concern on humans, animals, plants and property?

C - What are proposed solutions to the environmental concern?

D - What is your position on the environment concern and what course of action would you take as a concerned citizen?

3) Using appropriate bibliographical format, list all references.

SUGGESTED ENVIRONMENTAL CONCERN TOPICS

1. AIR POLLUTION
2. WATER POLLUTIOIN
3. NOISE POLLUTION
4. ACID RAIN
5. NUCLEAR WASTE
6. THERMAL POLLUTION
7. SEWAGE TREATMENT AND DISPOSAL
8. LAND FILLS
9. RECYCLING WASTES
10. ILLEGAL DUMPING
11. LOCAL POLLUTION PROBLEMS/CONCERNS

MASTER # VIII-1

Contemporary Science
Research Report
Environmental Concerns

Procedure:

1) Select one area of environmental concern from the list found below.

2) Discuss in a written report of 3-4 pages the following:

A - What is the cause of the environmental concern?

B - What is the impact of the environmental concern on humans, animals, plants and property?

C - What are proposed solutions to the environmental concern?

D - What is your position on the environmental concern and what cause of action would you take as a concerned citizen?

3) Using appropriate bibliographical format, list all references.

Suggested Environmental Concern Topics.

1) Air Pollution
2) Water Pollution
3) Noise Pollution
4) Acid Rain
5) Nuclear Waste
6) Thermal Pollution
7) Sewage Treatment and Disposal
8) Landfills
9) Recycling Wastes
10) Illegal Dumping
11) Local Pollution Problems

ACTIVITY #2

TITLE: THE ATMOSPHERE AND BIOGEOCHEMICAL CYCLES

PURPOSE:

To examine the earth's atmosphere and the natural biochemical cycles of the major components present.

OBJECTIVE:

Students should be able to:

1) Diagram and list characteristics of the earth's atmospheric regions.

2) Diagram the natural biogeochemical cycling of the following materials: carbon, oxygen, nitrogen. Each diagram must include the components and their relationship.

NOTE: Hydrologic cycle will be examined in Unit IX - Water Pollution. However, if the teacher wishes it can be introduced at this time.

MATERIALS:

Library resources (atmosphere and biogeochemical cycles)
oaktag paper
colored pencils

PROCEDURE:

NOTE: Divide students into small groups and assign each group the task of diagraming the atmosphere or one of the biogeochemical cycles.

1) Have each group complete assigned diagram on oaktag.

2) Allow student groups to present oral report to class explaining assigned diagram.

3) Conduct class discussion on diagrams using the following guide questions:

ATMOSPHERE

a) What problems would occur if our atmosphere were 100% oxygen?

b) Locate and describe the importance of ozone in our atmosphere.

c) What impact will depletion of the ozone layer have on life on earth?

d) Why are weather systems confined mainly to the atmosphere?

e) Describe the ways we use each of the atmospheric regions.

CARBON CYCLE

a) What form of carbon may be used by the plants to produce carbohydrates?

b) List the ways carbon is returned to the environment from living things?

c) Is any carbon used up in this cycle? If so, where? If not, why not?

d) How many activities of man involve the carbon cycle? Explain the possible effects of at least one of these activities on the normal function of the carbon cycle.

OXYGEN CYCLE

a) Identify and describe the many processes that use oxygen and how it is used.

b) Is it possible that the amount of oxygen in a system could be reduced or exhausted? Explain.

c) What conditions exist that may be disruptive to the oxygen cycle? Remember to consider the fact that the oxygen cycle is dependent on many other cycles.

NITROGEN CYCLE

a) Identify the various components and nitrogen compounds that link the components of the cycle together.

b) Is it possible to remove any of these links without disrupting the cycle? Explain.

c) What conditions are humans creating that disrupt the nitrogen cycle? How could these disruptive conditions be avoided or improved?

d) How does the fact that nitrogen can be lost to ocean sediments relate to soil erosion and to the total amount of nitrogen in terrestrial systems?

ACTIVITY #3

TITLE: TEMPERATURE INVERSION

PURPOSE:

To make a closed system - temperature inversion and study gas diffusion.

OBJECTIVE:

Students should be able to:

1) Construct a closed system temperature inversion.

2) Draw diagrams of normal air circulation and air circulation during temperature inversion.

MATERIALS:

Three 600 ml beakers
200 ml crushed ice
HCl
NH_4OH
10 mm glass tube
cotton wads

PROCEDURE:

TEMPERATURE INVERSION LAB

A temperature inversion results when the temperature in the upper atmosphere becomes hotter than the air at ground level. You will accomplish this in the following manner:

1) Place 200 ml of water in a 600 ml beaker and heat on the hot plate to 40-50 C. This is between warm and hot.

2) Place 200 ml of crushed ice in a 600 ml beaker.

These two beakers will represent the hot or cold source for this experiment.

3) The reaction chamber is a 600 ml in which one drop of HCL is placed inside on one side and one drop of NH4OH is placed inside on the other side. This will produce a smoke of NH4Cl (ammonium chloride).

4) Immediately place the beaker with crushed ice on top of the reaction chamber and observe the circulation of the smoke using a light behind the beaker to help in the observation. You should see a swirling of the smoke rising from the warm bottom cooling at the cold top and then falling back down to the bottom. This represents a normal air circulation in the earth's atmosphere which will disperse ground pollution by mixing it in the upper atmosphere.

5) Remove the beaker of ice and place the beaker of hot water on top of the reaction chamber. Observe the motion of the smoke in the chamber. You should see the swirling motion slow down and finally stop. This is the situation when a temperature inversion occurs. Because the surface air cannot mix with the upper atmosphere the pollutants are concentrated at the surface.

   a) Draw a picture of the air currents observed in normal circulation.

   b) Draw a picture which shows the density gradient of the smoke in a temperature inversion.

   c) Can you suggest a reason for the wind blowing from the ocean to the land?

DIFFUSION

Diffusion of gases can result in the dispersion of pollutants into the atmosphere. The rate of diffusion of a gas is a function of its molecular weight: the heavier the molecular the slower it moves, the lighter the molecule the faster it moves.

An experiment which demonstrates diffusion can be set up as follows:

1) Clamp a long, 10 mm glass tube in a horizontal position. Insert a small plug of cotton in each end. Simultaneously place 2 drops of HCl (hydrochloric acid) on the cotton on one end and 2 drops of NH_4OH (ammonium hydroxide) on the cotton on the other end.

2) You should observe, after a few minutes, a white precipitate form in the tube. The position the white precipitate will be a function of the rate of the diffusion of the two gases, HCl and NH_3. This rate depends on the molecular weight of the ga which can be determined by adding up the atomic weights. The atomic weight of H is 1.00, Cl is 35.5, and N is 14.0.

   a) Which gas diffused further in the tube? Measure the distance from either end of the tube to the white precipitate.

      HCl to precipitate ____________
      NH_3 to precipitate ____________

   b) What is the molecular weight of each gas?

      HCl _____ NH_3 _____

   c) Based on molecular weight which gas should diffuse faster?

   d) If the average molecular weight of air is 29.4, would NH_3 or HCl diffuse faster than air?

   e) How does diffusion aid in dispersing air pollutants?

ACTIVITY #4

TITLE:

TESTING FOR PARTICULATES IN AIR

PURPOSE:

To examine particulates present in the local environment.

OBJECTIVE:

Students should be able to:

1) Collect particulates in the local environment.

2) Observe and describe the types of particulates present in the air they breathe.

3) State the source of local particulates.

4) Describe the impact of particulates on humans, plants, animals and property.

MATERIALS:

Filter paper
Balance or laboratory scales
Glass jar or beaker
Distilled water
Magnifying glass
Tape and thumb tacks
pH tester - litmus paper (or
Universal pH indicator paper)
Petri dishes

PROCEDURE:

1) Record the weight of each piece of filter paper you plan to use.

2) Select one or more exposure sites for the filter paper; any place where dust collects will do. Weigh any tape used to secure the filter paper at the exposure site.

3) After 3 to 7 days weigh the filter paper again. Note any increase in weight or change in color of the paper.

4) Use the magnifying glass to note the particles collected on the filter paper.

5) Put some distilled water in a beaker or jar. Test the pH of the water and save the litmus paper.

6) Rinse the particles off the filter paper into the beaker and observe the particles with a magnifying glass.

7) Test the pH of the water with the particles suspended in the water. Compare the litmus paper to that used to test the distilled water in Item 5. Save both litmus papers.

8) Obtain a sample of particulate from a source such as an air conditioner or furnace filter. Rinse the particles into another beaker of distilled water. Observe what happens to the particles, check the pH, and compare the litmus papers.

DISCUSSION QUESTIONS

1) Did you find evidence of air pollution particulates in your own environment?

2) Did you find that in a short time a significant buildup of particles can occur.

3) Do particulates differ in size, shape, and color?

4) Although particulates remain suspended in the atmosphere, do they differ in density and solubility?

5) Does particulate matter from a home filter hold acid chemical compounds which will dissolve in water.

6) What possible sources of the particulates collected.

7) Discuss possible affects on humans, plants, animals and property.

ACTIVITY #5

TITLE:

GOVERNMENT, THE CITIZEN, AND THE ENVIRONMENT

PURPOSE:

To examine how the federal, state and local government agencies deal with environmental problems.

OBJECTIVE:

Students should be able to:

1) Recognize and describe how different levels of Government, as well as private and citizen's groups deal with the following problems of environment: pollution, radiation, population, land use, resources, transportation, water, and power.

MATERIALS:

None

PROCEDURE:

1) In order to recognize the relationship of the Federal Government to the problems of environment identify by name--and describe their principle activities--of any three of those major Federal agencies which deal with one or more of the following environmental themes: pollution, radiation, population, land use, resources, transportation, agriculture, water, and power.

2) In order to recognize the relationship of State Government to the problems of environment, identify by name--and describe their principle activities--of any three of those major State agencies which deal with one or more of the following encironmental themes: pollution, radiation, population, land use, resources, transportation, agriculture, water, and power.

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3) In order to recognize the relationship of private enterprise and citizens' organizations to the activities of State and Federal Government in dealing with the problems of environment, identify by name--and describe their principle activities--of any three of those organizations which relate to governmental activity in the following environmental themes: pollution, radiation, population, land use, resources, transportation, agriculture, water and power.

Unit IX

Water Pollution.

ACTIVITY #1

TITLE: THE EARTH'S HYDROLOGIC CYCLE

PURPOSE:

To examine the earth's water cycle

OBJECTIVE:

Students should be able to:

1) Describe the source of water for all living organisms.

2) Trace the path of water throughout the hydrologic cycle.

3) Describe the impact of human activities on the hydrologic cycle.

MATERIALS:

Master #IX-1.

PROCEDURE:

1) Prepare a transparency and student copies of Master #IX-1.

2) Instruct students to use diagram of hydrologic cycle to answer the following questions:

   a) Beginning with the ocean, state briefly where the ocean water goes, in what form(s), and how it is utilized by living organisms including man.

b) What is the energy source which powers the water cycle? What form does this energy take (light, heat, electricity, etc.) in various parts of the cycle?

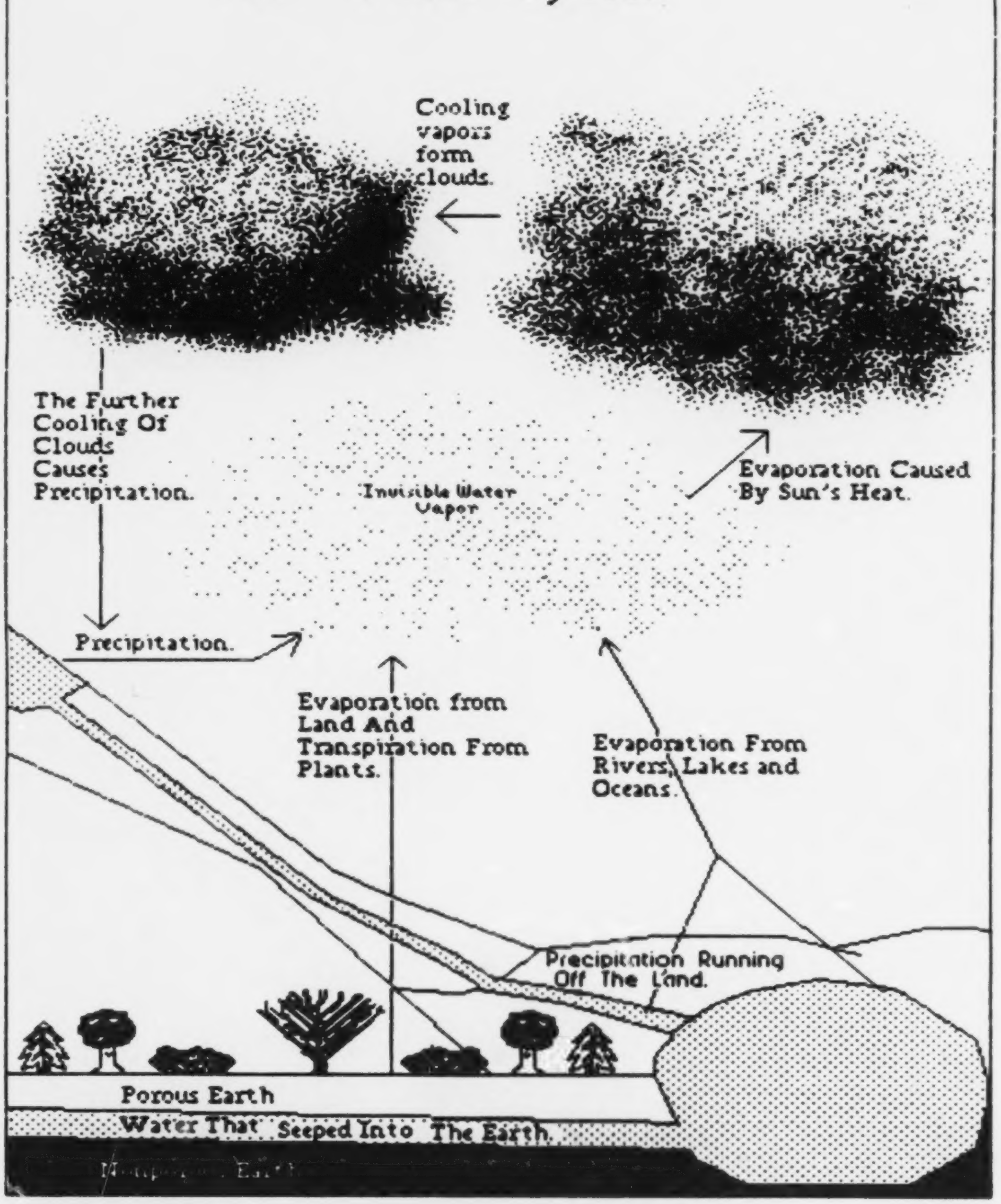
c) Water is cycled over and over. What becomes of the energy which powers the cycle?

d) PROBLEM: The farmer on the hill sprays his crops with a pesticide. How does this affect the water cycle? How does it affect other areas that are part of the water cycle?

e) Identify and trace the affects of another man made condition on the water cycle (i.e., deforestration, industrial waste, exhausting the deep storage water, paving the surface of fields).

MASTER #IX-1

The Water Cycle.


Cooling vapors form clouds.
The Further Cooling Of Clouds Causes Precipitation.
Invisible Water Vapor
Evaporation Caused By Sun's Heat.
Precipitation.
Evaporation from Land And Transpiration From Plants.
Evaporation From Rivers, Lakes and Oceans.
Precipitation Running Off The Land.
Porous Earth
Water That Seeped Into The Earth.
Nonporous Earth

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ACTIVITY #2

TITLE: UNDERGROUND WATER RESERVOIRS

PURPOSE:

To examine the source, utilization and contamination of a major portion of the country's drinking water.

OBJECTIVE:

Students should be able to:

1) Trace the path of drinking water from its source to its use in the home.

2) Describe how water is used on a daily basis.

3) List ways that the local water supply could become contaminated.

4) State various water conservation measures that could be undertaken to save water.

MATERIALS:

Master #IX-2.

PROCEDURE:

ACTIVITY #2A (PATH OF DRINKING WATER)

1) Prepare a transparency and student copies of Master #IX-2.

2) Have students answer the following guide questions:

   a) What is the water table?

   b) What is an aquifer?

   c) Where does the water in the aquifer come from?

   d) What are three other sources of drinking water in our country? (Reservoirs, streams and lakes).

ACTIVITY #2B (DAILY WATER USEAGE)

1) Divide class into small groups.

2) Have each group list water useage by the following sectors of society: residential, industrial, commercial, public.

3) Have students describe the impact of water loss to each of these sectors of society.

ACTIVITY #2C (WATER CONTAMINATION)

1) Have students list possible sources of water supply contamination (i.e., underground gasoline storage tanks, road salt, pesticides, hazardous waste sites).

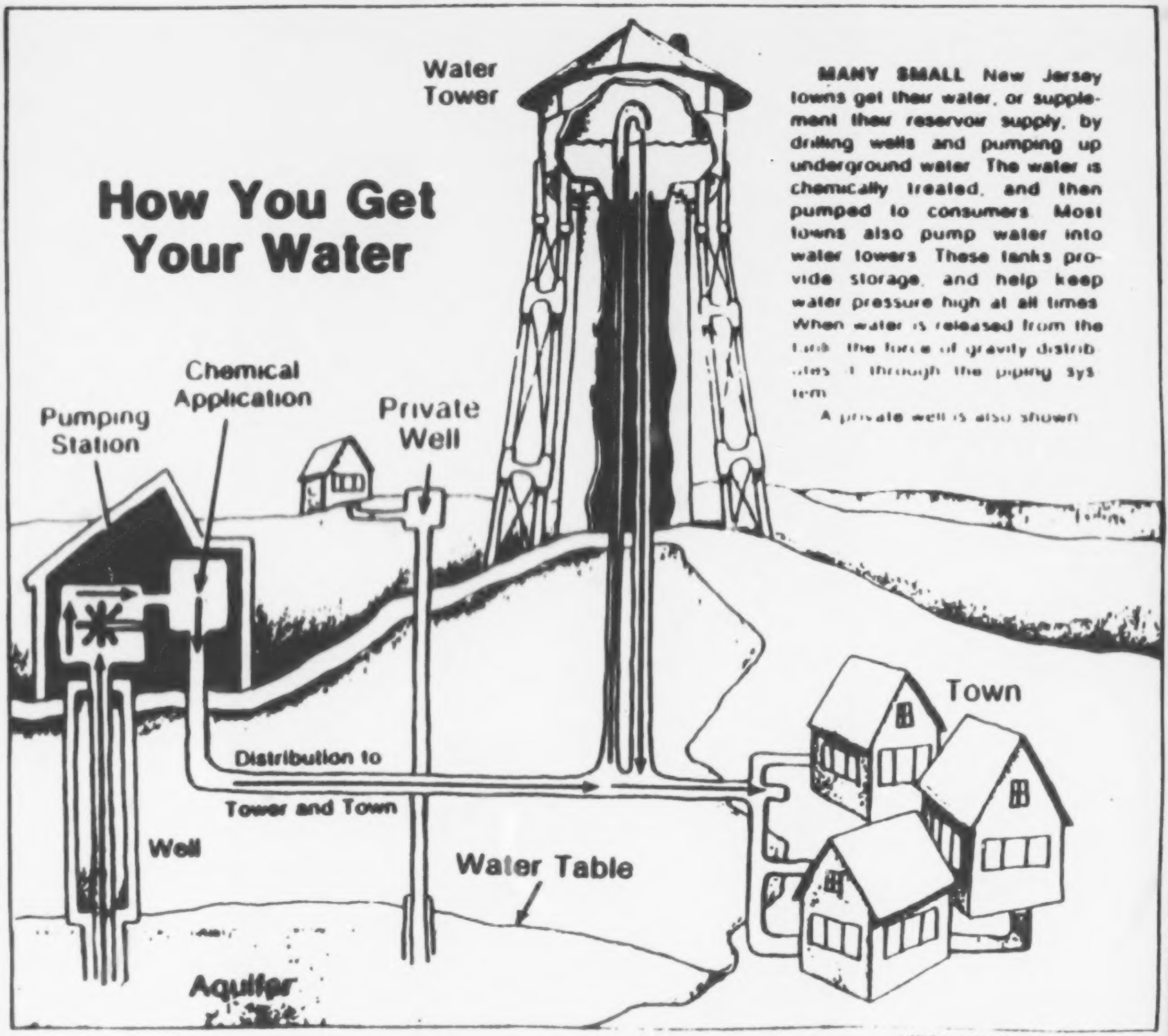
2) Have students describe local incidents of water supply contamination.

3) Ask for student solutions for prevention of water contamination and actions that should be taken when violators are identified.

ACTIVITY #2D (WATER CONSERVATION)

1) Have students list ways they can reduce personal water useage (i.e., reduce toilet flow, shorter showers, reduced flow showerheads, clean driveway with broom instead of a hose).

MASTER # IX-2



How You Get Your Water

MANY SMALL New Jersey towns get their water, or supplement their reservoir supply, by drilling wells and pumping up underground water. The water is chemically treated, and then pumped to consumers. Most towns also pump water into water towers. These tanks provide storage, and help keep water pressure high at all times. When water is released from the tank, the force of gravity distributes it through the piping system.

A private well is also shown.

Water Tower
Chemical Application
Pumping Station
Private Well
Distribution to Tower and Town
Well
Water Table
Aquifer
Town

PHENOMANO · Asbury Park Press

ACTIVITY #3

TITLE: WATER POLLUTION CLASSIFICATION

PURPOSE:

To familiarize students with the classification and terminology of water pollutants.

OBJECTIVE:

Students should be able to:

1) List the eight categories of water pollution.
2) Define and identify the pollutants in each of the eight categories.

MATERIALS:

Background information sheet

PROCEDURE:

1) List the eight categories of classification on chalkboard.
2) Describe the meaning of each category.
3) Have students provide examples of pollutants for each category with teacher assistance.

BACKGROUND INFORMATION: WATER POLLUTION CLASSIFICATION

POLLUTION IS GENERALLY DEFINED AS THE RESULT OF SUBSTANCES INTRODUCED INTO THE ENVIRONMENT BY HUMAN ACTIVITIES WHICH ARE DETRIMENTAL TO PLANTS AND ANIMALS.

In the most simple classification, pollution may be divided into eight categories:

(1) **NUTRIENTS**--dissolved inorganic elements and compounds which increase photosynthetic activity. Sewage is among the most common nutrient sources.

(2) **OXYGEN CONSUMING MATERIALS**--chemical and biological additions which remove dissolved oxygen from the water. Examples are sewage and organic matter.

(3) **PARTICULATE MATTER**--finely dissolved particles which remain in the water column for long periods of time. Their eventual settlement may have detrimental effects on benthic organisms. Examples are silts from dredging, or erosion, or particulate matter from industrial discharges.

(4) **TOXIC SUBSTANCES**--chemicals that cause death or which block or slow down physiological processes. These include thousands of biocides and toxic materials from human activities such as industrial outfalls, non-point sources, and mine leaching.

(5) **HEAT (THERMAL ENERGY)**--temperature increases in an aquatic environment may cause complex changes Heat can increase biological activity to a certain point beyond which organisms sufferr distress.

(6) **RADIOACTIVE WASTE**--elements and compounds emitting ionizing radiation. Long-term health hazard affecting all living organisms.

(7) **WATER DIVERSIONS**--excess fresh water introduced into an estuary or excess salt added to fresh or brackish water.

(8) **TRASH**--non-degradable refuse. Six million tons per year are dumped in the ocean.

Any of the above primary pollutants may combine to form synergistic substances.

ACTIVITY #4

TITLE: TOXIC WASTES

PURPOSE:

To identify and explain the effects of toxic wastes present in water resources.

OBJECTIVE:

Students should be able to:

1) Conduct library research on toxic wastes.

2) Describe the history, dangers, method of exposure and protective action for each toxic waste.

MATERIALS:

Library resources (Water Pollution)

PROCEDURE:

1) Provide each student with the following list of toxic wastes:

   a) Dioxin
   b) Polychlorinated biphenyls
   c) Radioactive waste
   d) Asbestos
   e) Trichloroethylene
   f) Benzene
   g) Lead
   h) Mercury
   i) Sewage sludge
   j) Other herbicides or pesticides

2) Have the students conduct library research on toxic waste topic assigned.

3) Instruct students to research the following information:

   a) Describe the historical development of the toxic waste.

b) What dangers to humans, plants, animals, and property are posed by the toxic waste?

c) How are hummans, plants, animals, and property exposed or contaminated by the toxic waste?

d) What protective measures can be employed to prevent exposure or contamination by the toxic waste?

ACTIVITY #5

TITLE: SEWAGE TREATMENT PROCESS

PURPOSE:

To examine the method employed to treat human sewage.

OBJECTIVE:

Students should be able to:

1) Diagram the sewage treatment process.
2) Describe the process and effectiveness of each stage of treatment.
3) State the type of sewage treatment used locally.
4) Evaluate the effectiveness of the local sewage treatment facility.
5) Recommend changes to improve (upgrade) local treatment plant and plan for future expansion in the event of a population increase.

MATERIALS:

Master #IX-4

PROCEDURE:

1) Prepare transparency and student copies of Master #IX-4.
2) Trace the steps in the sewage treatment process.
3) Have students write a description of each stage and the process that occurs at each state of treatment.
4) Take a class trip to local treatment plant or have a group of students visit plant and obtain information from plant manager describing the treatment process used.

5) Have class examine the information and:

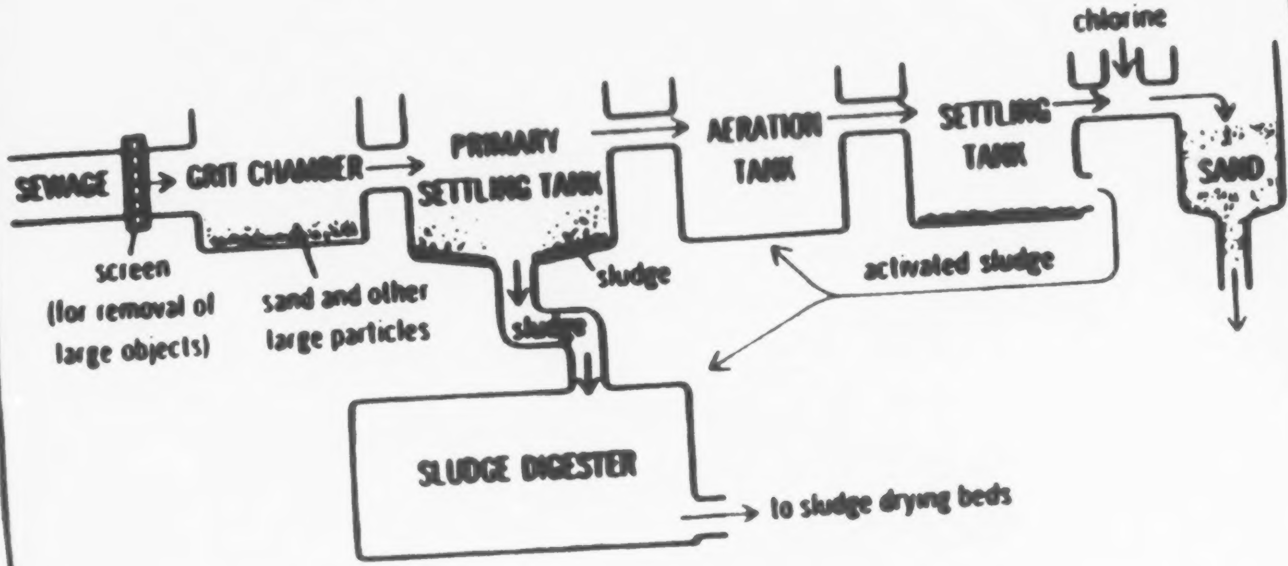
  a) Evaluate the effectiveness of the local sewage treatment facility.

  b) Recommend immediate changes needed to upgrade facility.

  c) Recommend future changes anticipated.

MASTER #IX-4

SEWAGE TREATMENT PROCESS


chlorine
SEWAGE
GRIT CHAMBER
PRIMARY SETTLING TANK
AERATION TANK
SETTLING TANK
SAND
screen (for removal of large objects)
sand and other large particles
sludge
sludge
activated sludge
SLUDGE DIGESTER
to sludge drying beds

ACTIVITY #6

TITLE: ACID RAIN

PURPOSE:

To examine how acid rain is produced and the present and future environmental impact.

OBJECTIVE:

Students should be able to:

1) Identify sources of acid rain.
2) Describe and write chemical reactions to explain acid rain formation.
3) Provide examples of the environmental impact of acid rain on humans, plants, animals and property.
4) Locate on U.S. maps the areas impacted by acid rain.
5) Predict future consequences of acid rain.
6) Suggest methods to control or prevent acid rainfall.

MATERIALS:

Masters #IX-5 and #IX-6

PROCEDURE:

1) Prepare transparencies and student copies of Masters #IX-5 and #IX-6.
2) Have students examine acid rain diagram and answer the following questions:
   a) Name the two gases which produce acid rain.
   b) What are two sources of each of the gases that produce acid rain.

c) What are effects of acid rain on humans, plants, animals, and property (obtain information from students who've prepared research reports on acid rain during air pollution unit).

d) What are possible solutions to eliminate acid rain (e.g., industrial scrubbers, limit automotive use in certain areas, alternative energy sources).

3) Have students examine map of eastern U.S. and diagram of pH scale and answer the following questions:

a) Where are the major sources of sulfer-dioxide in the eastern U.S.?

b) What areas are most sensitive to acid rainfall?

c) What is measured by pH scale?

d) What is the range of substances identified as basic (alkaline)?

e) What is the range of substances identified as acidic?

f) What is the pH of neutral substance?

g) Identify two strong bases. pH?

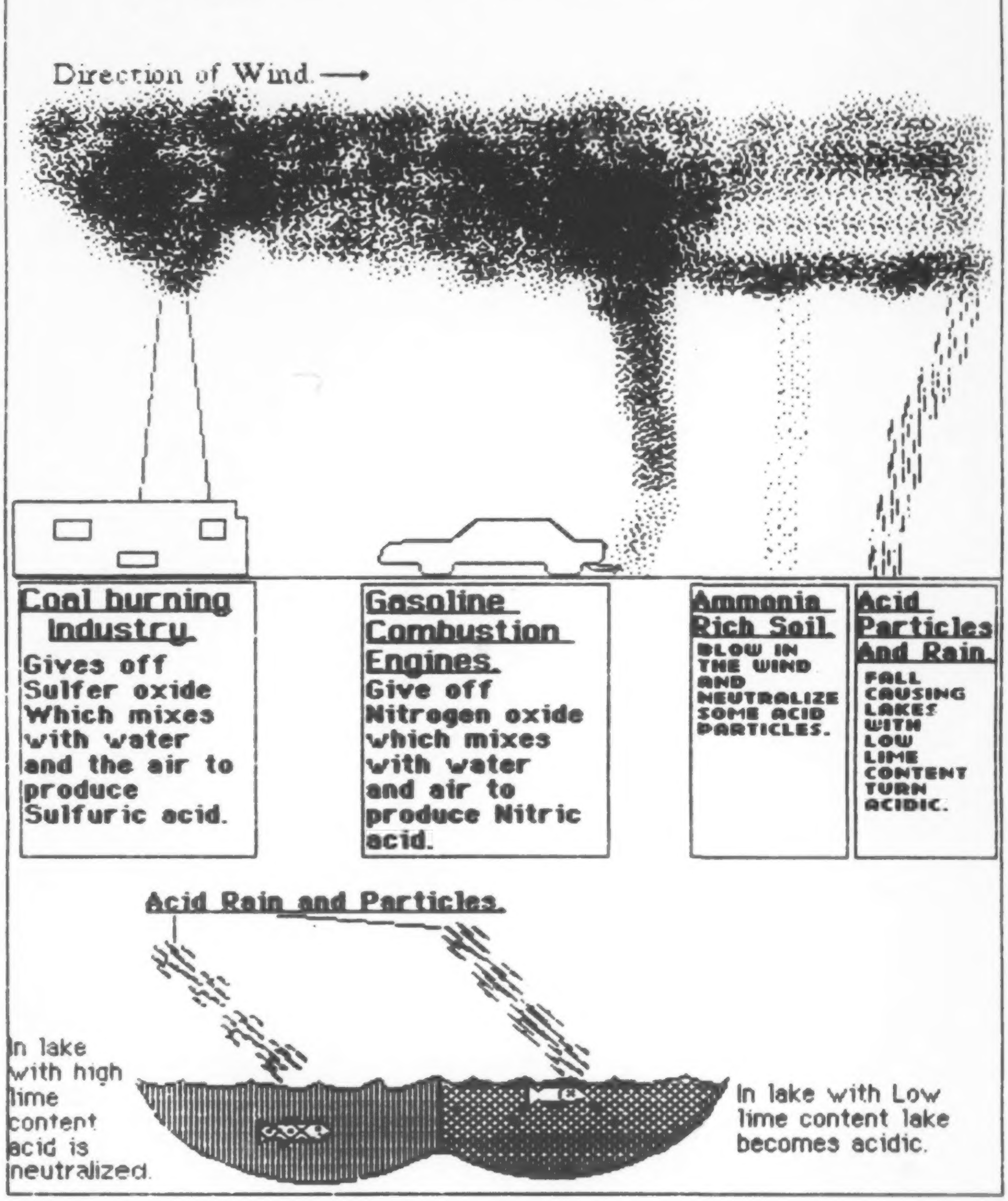
h) Identify two strong acids. pH?

i) What is the pH range of acid rain?

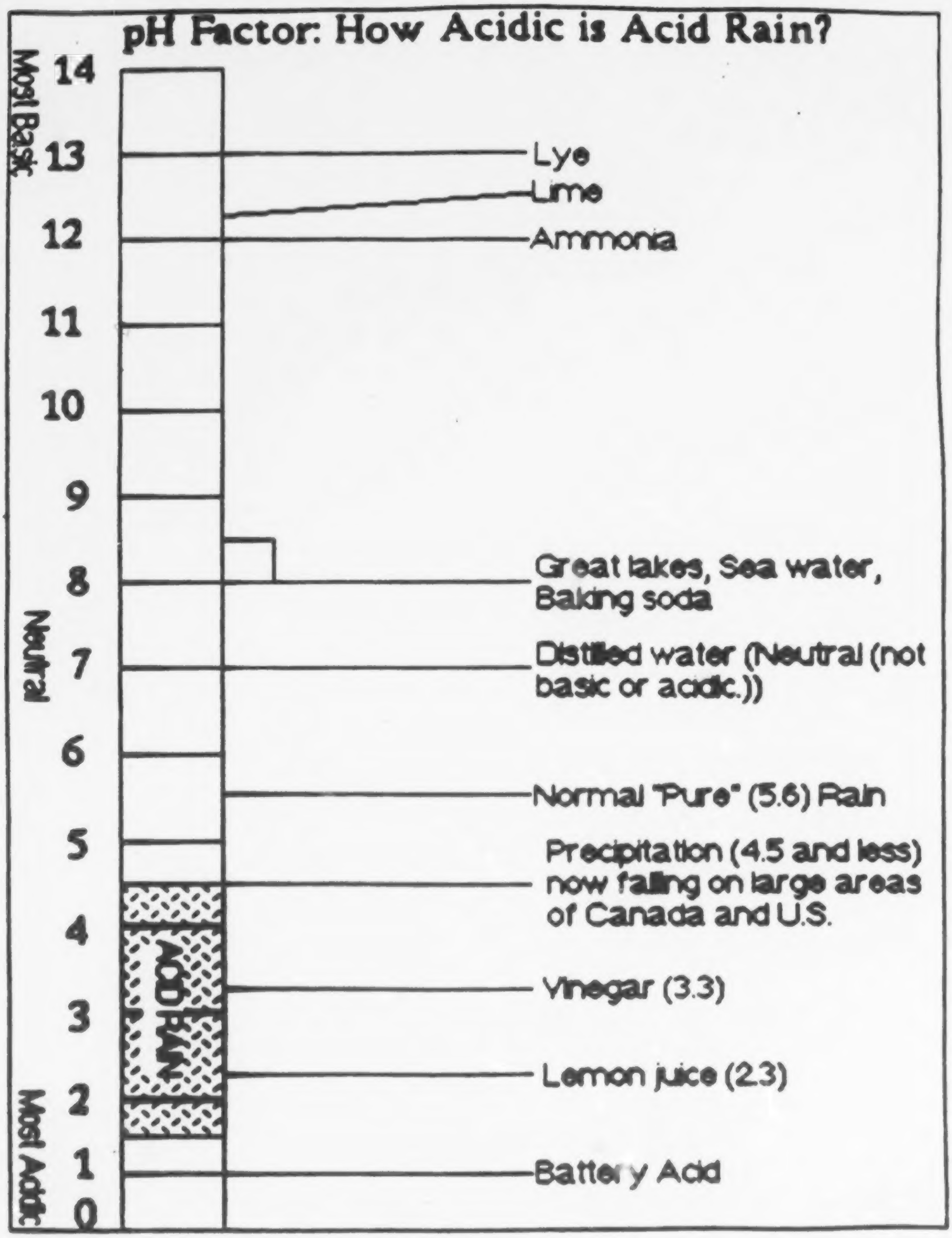
j) What is the pH of normal rainfall?

MASTER #IX-5

Formation Of Acid Rain.


Direction of Wind. →
Coal burning Industry.
Gives off Sulfer oxide Which mixes with water and the air to produce Sulfuric acid.
Gasoline Combustion Engines.
Give off Nitrogen oxide which mixes with water and air to produce Nitric acid.
Ammonia Rich Soil.
BLOW IN THE WIND AND NEUTRALIZE SOME ACID PARTICLES.
Acid Particles And Rain.
FALL CAUSING LAKES WITH LOW LIME CONTENT TURN ACIDIC.
Acid Rain and Particles.
In lake with high lime content acid is neutralized.
In lake with Low lime content lake becomes acidic.

pH Factor: How Acidic is Acid Rain?



ACTIVITY #7

TITLE: WATER POLLUTION FIELD STUDY

PURPOSE:

To investigate local water bodies for evidence of pollution.

OBJECTIVE:

Students should be able to:

1) Collect water samples from local water resources (e.g., lakes, streams, ponds, reservoirs, ocean).
2) Analyze specific chemical and biological components of water resource.
3) Draw conclusions from data collected as to whether or not water resource is polluted and to what degree.
4) Prescribe action to improve the condition of the water resource.

MATERIALS:

Water test kit
Microscope
pH paper
Glass slides
Cover slips
Screw top vials or bottles
Water samples
Lens paper
Paper towels
Test tube rack
Funnels
Test tubes
Filler paper
Rubber gloves

PROCEDURE:

1) Divide students into small groups and assign (or allow students to select) each group a water resource (e.g., lake, river, stream, pond, ocean) from which they will collect water samples.
2) Have students collect water samples and also TAKE PHOTOGRAPHS or VIDEOTAPE the area where water samples are obtained.

3) Have students observe and report the following water collection site information:

a) Type of area (e.g., recreational, industrial residential, commercial).

b) Other sources of water feeding into water collection site.

c) General appearance (e.g., color, clarity, debris) of collection site.

d) Evidence of pipes or storm drains leading into collection site.

4) LABORATORY TESTING

a) NOTE: All lab work MUST be performed with students wearing rubber gloves at all times and goggles when chemical tests are performed.

b) Instruct students to conduct the following tests on water sample:

- Color
- Turbidity (clarity of sample)
- Odor
- Oil (presence or absence of)
- pH
- Filtration (examine filter paper and filtered water)
- Test dissolved oxygen (use water test kit)
- Test phosphate content (also shake and observe for foam)
- Microscopic examination (types and concentration) of microscopic organisms.

c) Have each group prepare a final report for presentation to class.

d) Encourage students to submit reports to the local or county health department if they determine the water resource presents a potential health or environment impact on the community.

NOTE: The photos, slides, or videos can be used for future comparison studies to demonstrate changes.

ACTIVITY #8

TITLE: GETTING INVOLVED IN ENVIRONMENTAL CONCERNS

PURPOSE:

To make students aware of public hearings/meetings relating to environmental concerns and how they can voice personal concerns on local/county/state environmental issues.

OBJECTIVE:

Students should be able to:

1) Locate the date, time, and location of public hearings/meetings on environmental issues.

2) Research background information pertinent to topic being discussed at hearing/meeting.

3) Pose questions at hearing/meeting to further understand the issues.

4) Conduct a hearing/meeting on environmental issues in school.

MATERIALS:

Local/county newspapers
Library resources

PROCEDURE:

1) Instruct the students to select one environmental topic of current interest listed below and plan to attend a public hearing/meeting to learn more about the issue.

TOPICS

- Hazardous/toxic waste disposal
- Landfills
- Sewage collection and disposal
- Source separation/recycling

2) WHERE'S THE HEARING? - Your municipal or county office can inform you of any forthcoming: 1) Public hearings, 2) Public meetings, or 3) Informational meetings dealing with these topics. You can also find public hearings listed near the classified section of most newspapers. In your own community, plan to attend a planning board or zoning board of adjustment meeting. Try to prepare for any of these meetings by reading the minutes of the previous meeting, news accounts of previous meetings and by getting a copy of the agenda for the next meeting, which may be obtained from the municipal building of your community.

3) GETTING PREPARED: Collect information to have a class discussion on the subject your class chose. This discussion will let you see exactly what you do know and what areas require further researching.

Go to the school or public library. Read as many books or pamphlets on your subject as you can find. Use the Reader's Guide to Periodical Literature and the library card file.

Your public library may have a newspaper file. Look through the copies of old newspapers for any articles about your subject. If you can, make a copy of these articles for a file in your classroom. If not, send a committee of two or three to your nearest local or area newspaper to research the files. It should have a file of clippings called a "morgue."

Contact members of the different organizations as well as town or city officials that will be appearing at the hearing/meeting. Get their views of your subject. Have a class discussion after the information has been gathered by your class.

a) Discuss what aspects of your topic you feel will have more importance at the hearing or what you feel will be discussed.

b) What your class would like to hear discussed at the meeting.

c) A series of questions should be written with questions pertaining to aspects your class wants to know more about or what issues that will discuss.

d) Discuss as a class what you think the outcome of the hearings might me.

4) AT THE HEARING

a) Your whole class is welcome to attend any of the hearings or meetings.

b) Choose 1 or 2 classmates as designated spokespersons if any questions are to be asked by your class.

c) The remainder of the class may take notes.

d) A tape recorder may be of help if permission to operate one during the hearing/meeting is given.

5) BACK IN CLASS - discuss what new information has been gained on your subject after attending a public hearing/meeting.

a) Did the hearing go as you expected?

b) Did you feel the hearing had any significant value?

c) If your class tried to present a differing viewpoint, were your ideas well received?

d) What changes, if any, do you feel will come about because of the public hearing/meeting?

e) A concluding discussion on possible or desirable alternatives is a good ending for your class discussion about the hearing(s).

6) ON YOUR OWN: As a class, you may wish to have a hearing or meeting on the subject(s) of the hearing(s) your class chose to attend. Challenge any other class to participate in a debate on your subject.

Maybe setting up a meeting/hearing at your school would help inform your neighbors about problems dealing with solid waste. If you decide to do this:

a) You will first have to get permission to use the school auditorium.

b) Contact community officials. Find out what problems the community officials think would be beneficial to your neighbors if you were to conduct a meeting at the school.

c) Invite community officials and organizations with differing viewpoints concerning the problem considered at the hearing.

d) Prepare a report which your designated spokesperson will present at the hearing. This report should reflect your class's opinion on the subject chosen.

e) If the subject your class chose for the meeting/hearing in the school is different from the subject discussed in the original public hearing, follow the steps within this lesson to research the new subject.

f) Inform your neighbors and fellow students about the hearing. Make posters and put them up around your school and neighborhood. Display the posters at least 2 weeks before the hearing/meeting.

Unit X

Noise Pollution.

ACTIVITY #1

TITLE: HUMAN EAR

PURPOSE:

To examine the structure and function of the human ear.

OBJECTIVE:

Students should be able to:

1) Identify parts of the human ear.
2) Describe the function of the structures found in the human ear.
3) Trace the path of sound waves through the ear.

MATERIALS:

Diagram or transparency of human ear.

PROCEDURE:

1) Provide students with a diagram of the human ear.
2) Have students label parts of the human ear.
3) Have students explain the function of each part in their notebooks.
4) Describe the path of sound waves through the human ear.
5) Have students identify the parts of the ear most susceptable to damage.

ACTIVITY #2

TITLE: THE MEASUREMENT OF SOUND

PURPOSE:

To examine how sound is measured and understand the sound levels of everyday activities.

OBJECTIVE:

Students should be able to:

1) Observe how a decibel meter detects and measures sound.

2) Construct a decibel scale for selected sounds.

MATERIALS:

Decibel meter
Master #X-1

PROCEDURE:

1) Demonstrate how the decibel meter measures sound.

2) Define the term decibel.

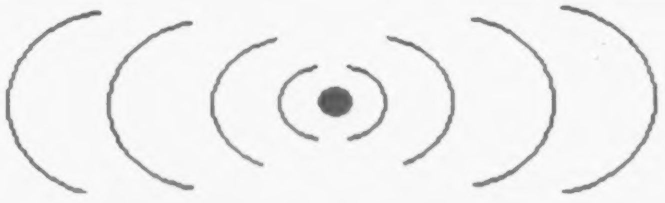
3) Prepare transparency of Master #X-1 and student copies with decibel levels of daily activities omitted (except for location of normal conversations).

4) Have students write the location of daily activities on the chart at the decibel level they estimate the activity would produce.

   NOTE: More than one activity may be placed at the same decibel level on chart.

5) Show students transparency of decibel levels with actual location of activities. Have students check the number of activities they placed correctly on decibel scale.

MASTER #X-1



DECIBEL LEVELS

200	Rocket Launching
180	
160	
140	Jetplane, gunshot
130	Pneumatic riveter, Rock band
120	Carhorn, Subway, Thunder
110	Sandblasting, Loud stereo
100	Punch press, outboard
90	Heavy traffic, Blender
80	Average factory, Typewriter
70	Noisy office / restaurant
60	NORMAL CONVERSATION
50	Average home, Quiet street
40	Refrigerator, Private office
30	Soft whisper, Country home
20	Rustling leaves
10	Normal breathing
0	Faintest audible whisper

Hearing loss may occur from long exposure

May cause pain

ACTIVITY #3

TITLE: NOISE POLLUTION INVESTIGATIONS

PURPOSE:

To conduct selected noise pollution investigations.

OBJECTIVE:

Students should be able to:

1) Test effects of various materials on sound.

2) Test effects of noise on mental concentration.

3) Survey local industrial noise sources.

4) Determine local community noise zoning.

5) Survey community noise levels.

MATERIALS:

Tape recorder
Decibel meter (if possible)
Cardboard boxes
Plywood
Wool cloth
Vinyl flooring
Cotton (wide strips)

PROCEDURE:

ACTIVITY #3A
(EFFECTS OF MATERIALS ON SOUND)

1) Tape record rock music at a constant level.

2) Line several large boxes with a variety of materials.

   a) Plywood
   b) Wool cloth
   c) Vinyl flooring
   d) Cotton

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3) Play the tape in each of the boxes.

4) Walk away from the box with the tape.

5) Record the distance at which the sound was last heard.

6) Have students explain the results.

ACTIVITY #3B
(EFFECTS OF NOISE ON MENTAL CONCENTRATION)

1) Divide class into two groups.

   a) Group #1 works math word problems in quiet room.

   b) Group #2 works math word problems while listening to loud rock music.

2) Compare results of work done in quiet and noisy surroundings.

ACTIVITY #3C
(SURVEY LOCAL INDUSTRIAL NOISE)

1) Instruct students to survey local community for industrial noise.

2) What are the types of noise produced (estimate of decibel level)?

3) What are the sources of these noises?

4) Are there legal noise limits? Check with official in charge of noise abatement in city hall or township office.

ACTIVITY #3D (COMMUNITY NOISE ZONING)

1) Have students research amount of noise allowed in each zone.

2) Are time restrictions on noise allowances?

3) Why are certain levels of noise allowed in certain places and not in others?

ACTIVITY #3E (COMMUNITY NOISE SURVEY)

1) Have students conduct a community noise survey.

2) Tape record noise and lack of it.

   a) Record times, places, activities.

3) Places to survey

   a) Industrial areas

   b) Classrooms

   c) Cafeteria

   d) Own yard

   e) Street

   f) Shopping center

4) Have students suggest ways areas surveyed can be quieted.

5) Have students report excessive noise violations to local authorities.

6) Have students suggest ways they can personally improve noise levels.

ACTIVITY #4

TITLE: EFFECTS OF NOISE POLLUTION

PURPOSE:

To examine the effects of noise pollution of humans, animals and property.

OBJECTIVE:

Students should be able to:

1) Describe the effects of noise pollution on humans, animals and property.

2) Suggest methods to solve noise pollution problems for the local situations examined.

MATERIALS:

Student research reports (previously completed)
Library resources

PROCEDURE:

1) Use previously prepared students research reports on noise pollution or teacher prepared information to demonstrate the effect of noise pollution on humand, animals and property.

2) Have students suggest methods to reduce or prevent local noise pollution (record suggestions on chalkboard).

Unit XI
Energy Resources.

ACTIVITY #1

TITLE: U.S. ENERGY CONSUMPTION

PURPOSE:

To examine trends in U.S. energy consumption from 1970 to 2000.

OBJECTIVE:

Students should be able to:

1) Compare rates of energy consumption from 1970 to 2000.

2) Construct pie charts to depict energy consumption changes.

3) Calculate percent increases or decreases of specific segments of energy pie chart.

4) Analyze reason for observed changes in energy consumption.

MATERIALS:

Master #XI-1
Energy resource materials

PROCEDURE:

1) Either provide students with necessary data or have available energy resource materials for student research on U.S. energy consumption from 1970-2000.

2) Produce student copies of Master #XI-1.

3) Have students construct pie charts showing the percentage of energy consumption by the areas listed from 1970-2000.

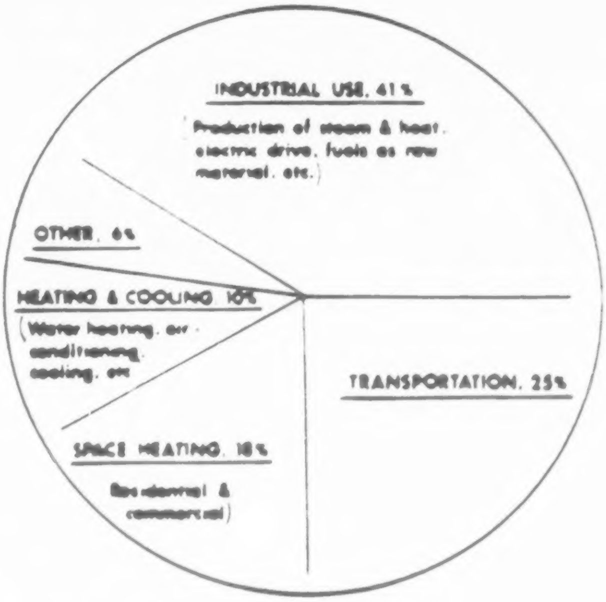
4) After completion of pie charts have students answer the following questions:

a) Which area of energy consumption showed the largest percent increase? Smallest percent increase? Give possible reasons for each.

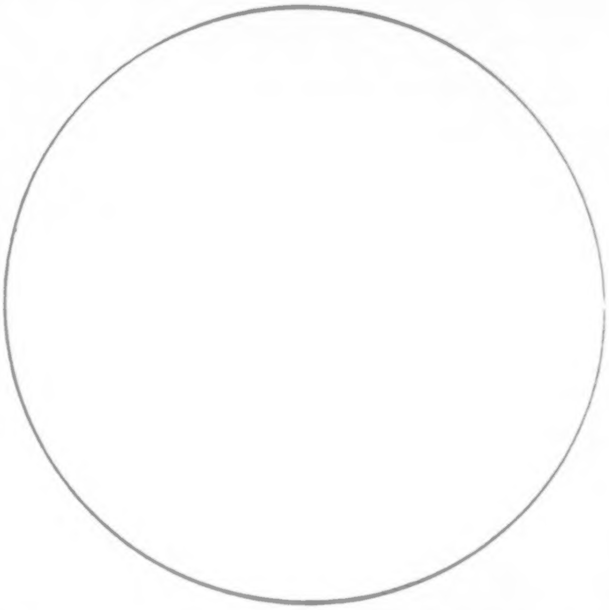
b) Calculate the number of energy QUADS (quadrillion BTU's) each area consumed.

MASTER #XI-1

ENERGY USE in the UNITED STATES (1970)



ENERGY USE in the UNITED STATES (   )



ACTIVITY #2

TITLE: U.S. ENERGY SOURCES

PURPOSE:

To examine the reliance on various sources of energy in the U.S. from 1850 to the year 2000.

OBJECTIVE:

Students should be able to:

1) Identify the major U.S. energy resources.

2) Identify the principle energy resources used in 1850.

3) Identify the principle energy resources that will be in use by the year 2000.

4) State the changes predicted in our reliance on the various energy resources by the year 2000.

5) Analyze the inpace on industry and society of a conversion from one energy resource to another resource.

MATERIALS:

Master #XI-2

PROCEDURE:

1) Prepare a transparency and student copies of Master #XI-2.

2) Instruct students to examine the graph of energy sources from 1850 to the year 2000 and answer the following questions:

   a) What are the current energy sources available in the U.S.?

   b) What were the chief energy sources used in 1850?

   c) What were the chief energy sources used in 1900?

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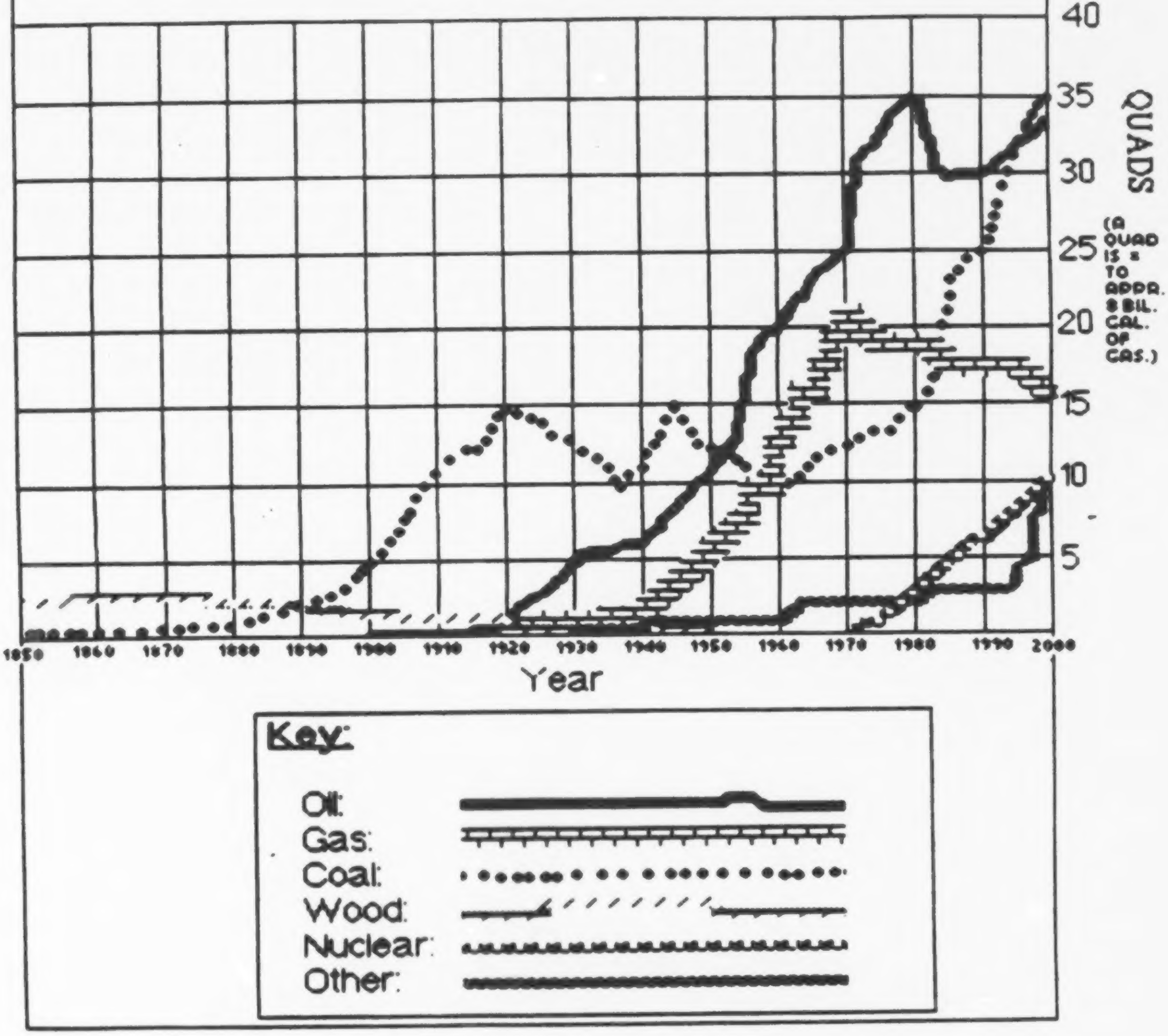
d) What was the chief energy source used in 1945?

e) What was the chief energy source used in 1980?

f) By the year 2000, what two energy sources are expected to increase in useage? What two energy sources are expected to decrease in useage?

g) What impact on industry and society will the increased use of coal and nuclear power as energy sources have?

The Way In Which U.S. Energy Sources Have Changed.



ACTIVITY #3

TITLE: TYPES OF ENERGY RESOURCES

PURPOSE:

To examine the current and proposed world energy sources.

OBJECTIVE:

Students should be able to:

1) Identify current and future energy sources.

2) State the availability of the current and future energy sources.

3) State the degree of technological development of the energy sources.

4) Evaluate the cost of use on development of the energy sources.

5) Evaluate the environmental impact of the energy sources.

MATERIALS:

Library resources on energy.

PROCEDURE:

1) Divide the students into teams of two.

2) Assign or have each team select one of the following energy resources for a written and oral report.

ENERGY RESOURCE

(A) COAL
(B) OIL
(C) NATURAL GAS
(D) NUCLEAR FISSION
(E) NUCLEAR FUSION
(F) HYDROELECTRIC
(G) SOLAR
(H) SOLID WASTE
(I) OCEAN
(J) WIND
(K) GEOTHERMAL
(L) SYNFUELS

3) Instruct student teams to research the energy resource for the following information:

a) How is the energy resource obtained?

b) What is the degree of availability of the energy resource?

c) What technology is availlable or must be developed to obtain energy resource?

d) What is the cost of obtaining the energy resource?

e) What is the environmental impact and human health risk of the energy resource?

ACTIVITY #4

TITLE: PERSONAL ENERGY CONSUMPTION

PURPOSE:

To investigate personal dependence on electrical energy for daily living.

OBJECTIVE:

Students should be able to:

1) Determine specific electrical energy demands in the home.
2) Construct a pie chart showing the percentage of electrical energy used in the home.
3) Estimate the electrical consumption (kilowatt-hours) of home appliances.
4) Calculate the annual electrical consumption in the home.
5) Propose methods to reduce personal energy consumption and conserve energy resources.

MATERIALS:

Personal energy demand and use Masters #XI-3 and #XI-4.
Conservation methods (source - power utilities/ conservation groups).

PROCEDURE:

ACTIVITY #4A
(ELECTRICAL ENERGY UTILIZATION IN HOME)

1) Prepare student copies of Master #XI-3 and #XI-4.
2) Instruct students to construct pie chart (Master #XI-3) showing the percentage home electrical demand for each area listed on the chart.

3) Obtain data showing kilowatt-hour consumption for selected home appliances (source - power utilities/consumer groups). Using Master #XI-4 have students fill in consumption rate date.

ACTIVITY #4B
(PERSONAL ENERGY CONSERVATION)

1) Divide students into small groups and assign each group an area of home electrical utilization from pie chart.

   a) Have each group prepare a list of conservation measures to reduce electrical useage.

   b) Have each group report their findings to the class.

2) Instruct each student to monitor for a one-month period the amount of kilowatt-hours of electricity used in the home. (If possible, have students read their electric meter on a daily or weekly basis).

   a) Place students back into original groups.

   b) Have each group prepare an average kilowatt-hour monitoring period. Report results to class.

   c) Using the appliances listed on Master XI-4 have each student rate the necessity of each item as:

   1 - Essential
   2 - Quite important, but not essential
   3 - Convenient, but NOT VERY NECESSARY

   NOTE: Conduct class survey of ratings and discuss results.

d) Have class discuss whether or not it would be:

- NECESSARY
- DESIRABLE
- POSSIBLE

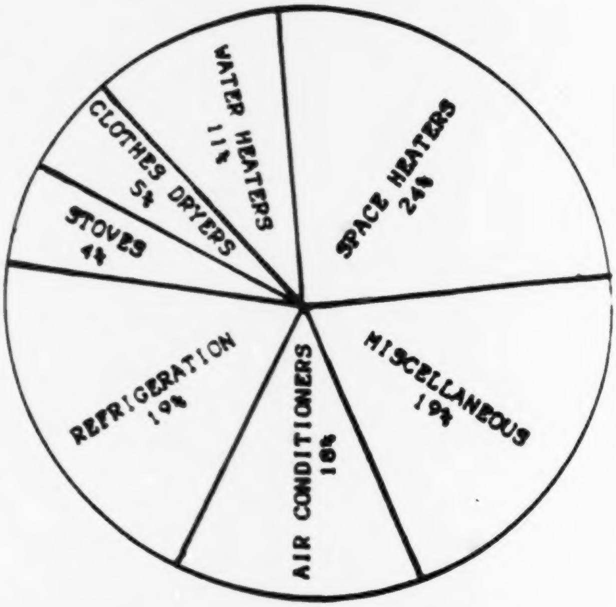
to restrict the use of any of the appliances on the list

e) Have students calculate the percent of kilowatt-hour consumption that could be achieved by the elimination or reduction in use of certain appliances.

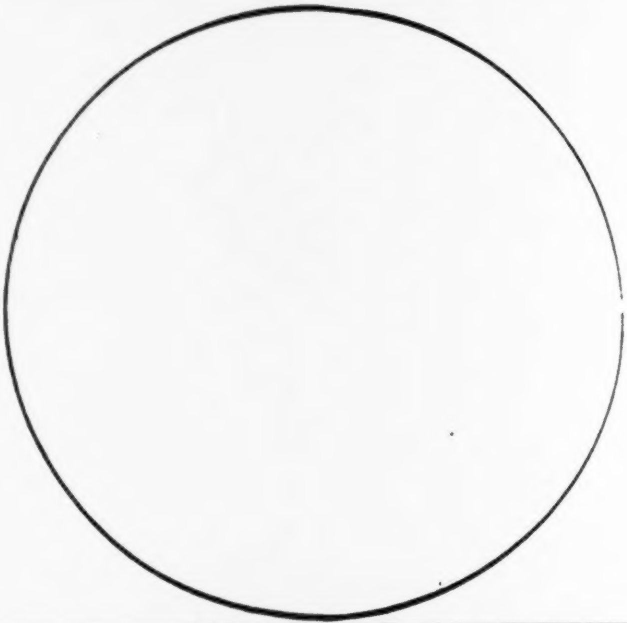
NOTE: Survey students on the following:

- What hardships would be encountered for each reduction or elimination of appliance useage.
- What is the likelihood that they or their families would practice this type of energy conservation?

ELECTRICAL ENERGY USED IN THE HOME (1970)



ELECTRICAL ENERGY USED IN THE HOME (   )



MASTER #XI-4

ESTIMATED ANNUAL CONSUMPTION of ELECTRICITY for VARIOUS APPLIANCES - 19__

APPLIANCE	KILOWATT-HOURS CONSUMED ANNUALLY (EST.)
AIR CONDITIONER	
CLOTHES DRYER	
COFFEE MAKER	
DEHUMIDIFIER	
DISHWASHER	
FOOD FREEZER	
FRYING PAN	
FURNACE	
HEAT PUMP	
HAIR DRYER	
HUMIDIFIER	
MICROWAVWE	
RANGE	
REFRIGERATOR-FREEZER (ALL TYPES)	
STEREO	
TELEVISION	
TOOTH BRUSH	
WASHING MACHINE	
WATER HEATER	
WATER PUMP	

ACTIVITY #5

TITLE: GENERATION OF ELECTRICITY FROM FOSSIL FUELS

PURPOSE:

To examine the process and impact of electric power production from fossil fuels.

OBJECTIVE:

Students should be able to:

1) Describe the process by which electricity is produced from burning coal, oil or natural gas.
2) Discuss the current and projected reserves of coal, oil and natural gas.
3) Evaluate the current and projected cost of producing electricity using fossil fuels.
4) Explain the environmental impact of burning coal, oil or natural gas.

MATERIALS:

Research data on fossil fuels

- % use current and future
- Estimated reserves of fossil fuels
- Environmental impact

Masters #XI-5, #XI-6, #XI-7

PROCEDURE:

1) Prepare a transparency and student copies of Master #XI-5.
    a) Discuss how electricity is produced in a fossil fuel generating plant.
    b) Have students describe the principle and function of the turbine, generator and condenser.

2) Prepare a transparency and student copies of Master #XI-6 and #XI-7.

   a) Provide students with most recent data on percentage of use for each fuel source shown. Have students write percentage on diagram (#XI-6).

   b) Provide students with most recent data on current and projected reserves of coal, oil and natural gas.

      - Have students write these figures on diagram (#XI-7).

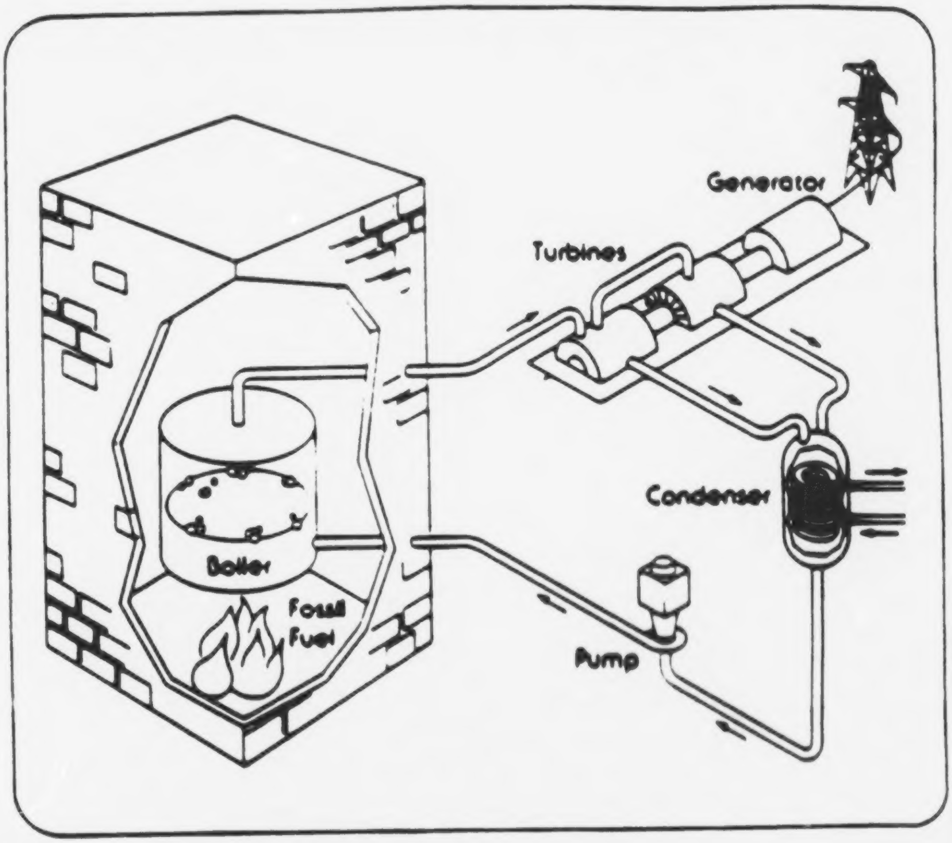
      - Discuss student solutions to depletion of oil and gas reserves.

   c) Have students make a cost comparison of producing electricity using coal, oil and natural gas.

   d) Have students compare environmental impact of burning coal, oil and natural gas for electric power production.

MASTER #XI-5

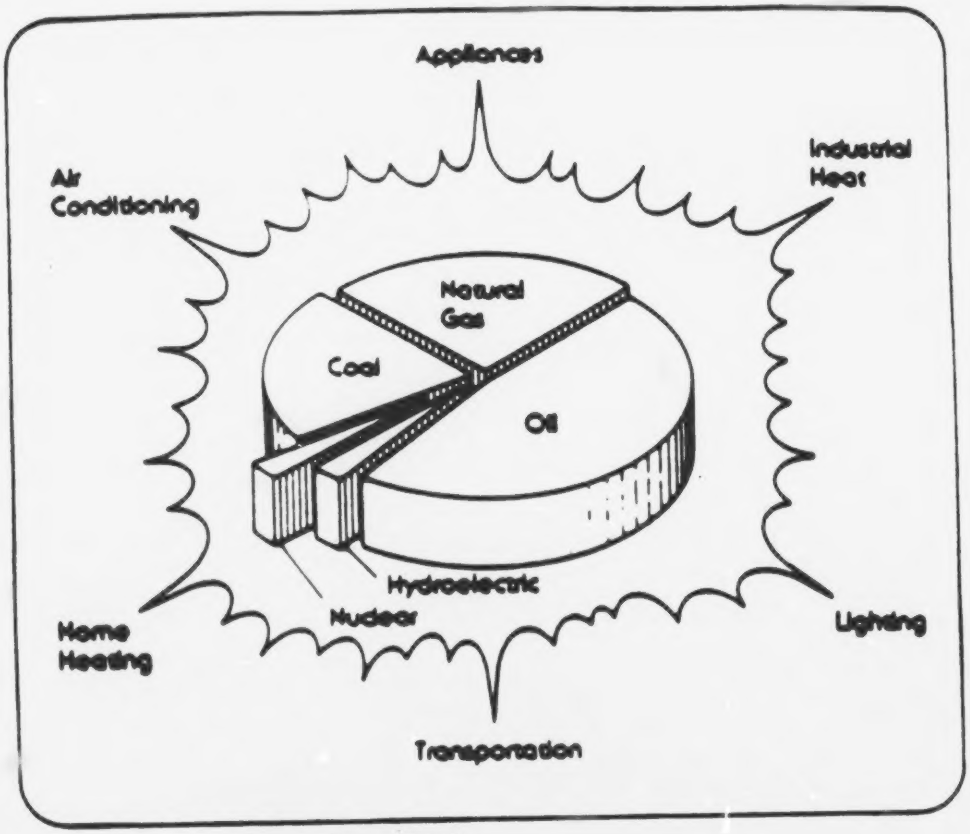
FOSSIL FUEL POWER PLANT


Generator
Turbines
Condenser
Boiler
Fossil
Fuel
Pump

Fossil Fuel Plants

In conventional fossil plants, oil, coal, and natural gas can be burned to produce heat. Regardless of its source, the heat is converted into steam in a boiler. The steam expands as it passes through a turbine. This process drives a generator, which produces electricity. As steam leaves the turbine, it is condensed and returned to the boiler in the form of water.

ENERGY SOURCES

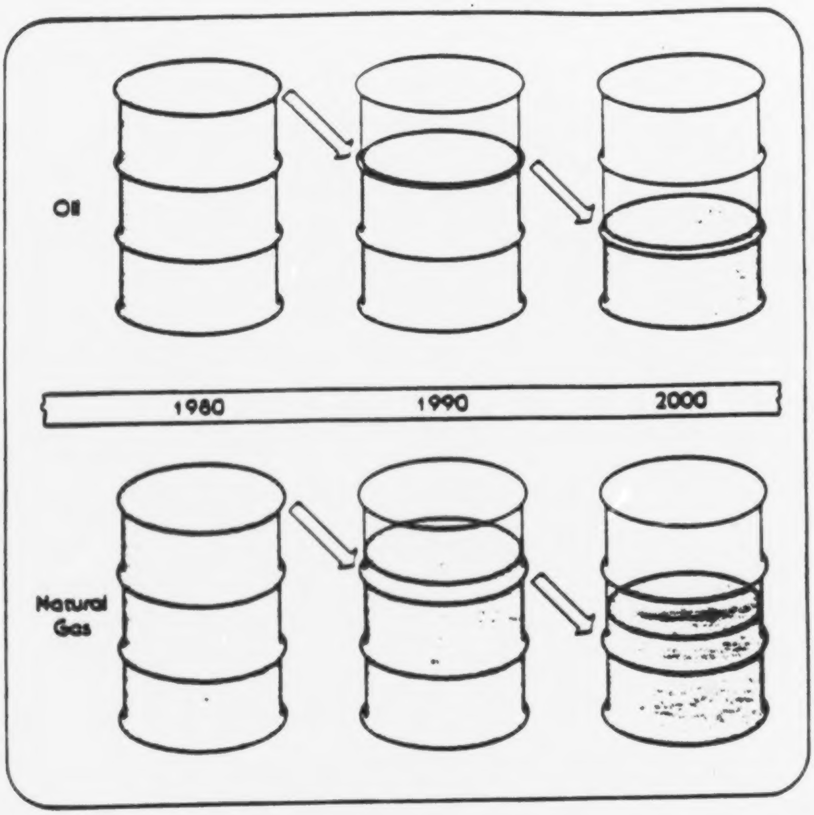

Appliances
Industrial Heat
Air Conditioning
Natural Gas
Coal
Oil
Hydroelectric
Nuclear
Home Heating
Lighting
Transportation

Current Use of Fuels

While there are many ways to produce energy, we do not use them all to the same extent. Some are not fully developed, while others are too expensive or of limited potential. In fact, most of the energy we use today comes from a few major sources--oil, natural gas, coal, uranium, and hydroelectric power. Two of these fuels, oil and gas, supply nearly three-quarters of the energy needs for the U.S.

MASTER #XI-7

OIL AND GAS CONSUMPTION



Oil and Gas Consumption

We know that the domestic supplies of oil and gas are limited. In fact, oil and gas deposits are being depleted rapidly. If we continue to use these fuels at the same rate we use them today, we will have consumed nearly one-quarter of all our oil and gas resources within the next ten years. If there are no significant new discoveries within 20 years, these valuable fuels will be half-way gone. Therefore, it is vital that we develop other energy sources that can replace oil and natural gas so that we may have a supply of energy far into the future.

ACTIVITY #6

TITLE: GENERATION OF ELECTRICITY BY NUCLEAR FISSION

PURPOSE:

To examine the process and impact of electric power production from nuclear fission.

OBJECTIVE:

Students should be able to:

1) Describe the process by which electricity is produced from nuclear fission?
2) Discuss the current and projected reserves of uranium.
3) Evaluate the current and projected costs of producing electricity from nuclear fission.
4) Explain the environmental impact of using nuclear power.
5) Compare the processes of nuclear fission and nuclear fusion.

MATERIALS:

Research data on nuclear fuels

- % use current and future
- Estimated reserves
- Environmental impact

Masters #XI-8, #XI-9, #XI-10, #XI-11

PROCEDURE:

1) Prepare a transparency and student copies of Master #XI-8.
   a) Review the nuclear fission process.
   b) Point out to students the two main by-products of fission (heat and fission products).

2) Prepare a transparency and student copies of Masters #XI-9, #XI-10, #XI-11

   a) Discuss the process by which electricity is produced in a nuclear power plant (#XI-9).

   b) Discuss the components of nuclear fuel assembly (#XI-10) the reactor core and the reactor vessel (#XI-11).

3) Provide students with data on estimated fuel reserves.

   - Have students compare nuclear fuel reserves to those of fossil fuels.

4) Provide students with data on cost estimates for nuclear power production of electricity.

   - Have students make a cost comparison of producing electricity from fossil fuels versus nuclear fuel.

5) Have students discuss environmental impact of nuclear power generation of electricity.

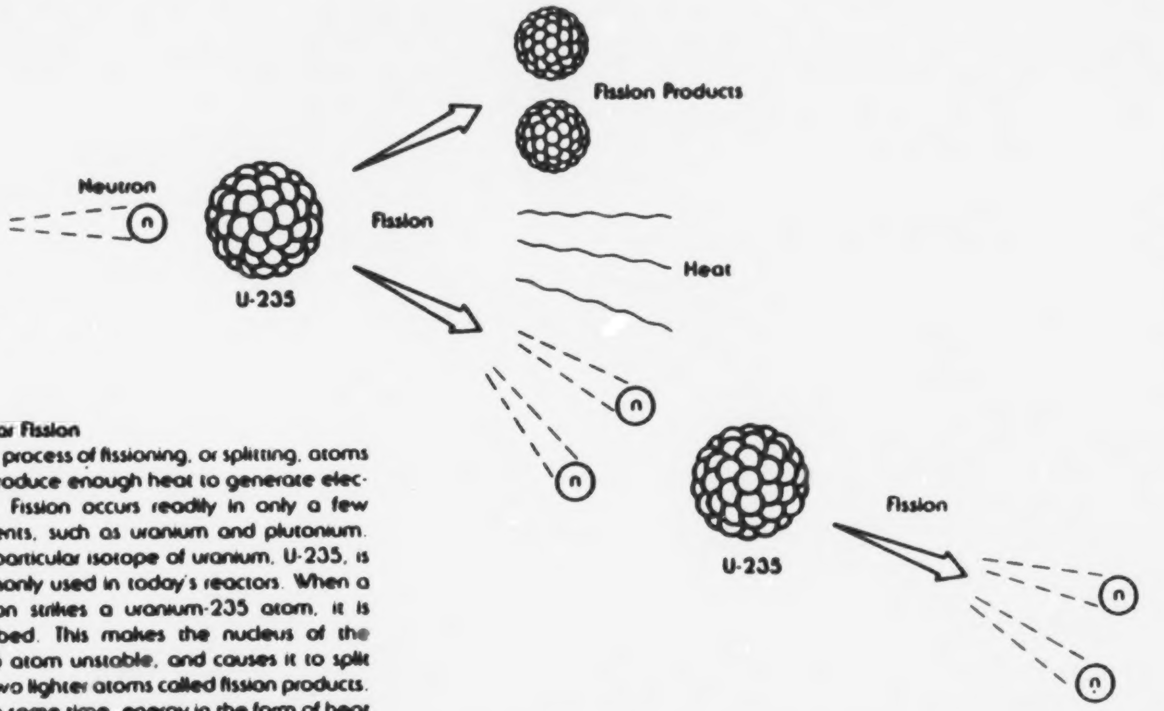
   NOTE: Discuss impact of Three Mile Island and Chernobyl.

6) Have students list advantages and disadvantages of fossil fuel versus nuclear power production of electricity.

7) Have students write to Princeton University in Princeton, New Jersey for information on its fusion research program. Direct students to compare nuclear fission to nuclear fusion process. Discuss advantages and disadvantages of each form of power.

MASTER #XI-8

NUCLEAR FISSION PROCESS

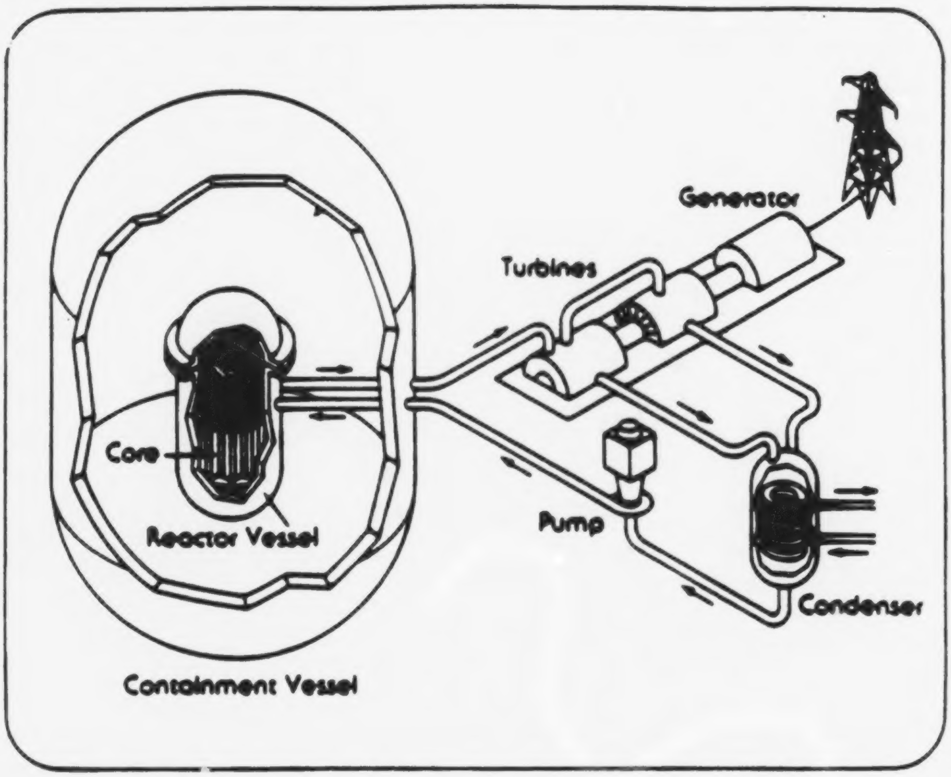


Nuclear Fission

The process of fissioning, or splitting, atoms can produce enough heat to generate electricity. Fission occurs readily in only a few elements, such as uranium and plutonium. One particular isotope of uranium, U-235, is commonly used in today's reactors. When a neutron strikes a uranium-235 atom, it is absorbed. This makes the nucleus of the U-235 atom unstable, and causes it to split into two lighter atoms called fission products. At the same time, energy in the form of heat is released along with two or three neutrons. The neutrons can strike other uranium atoms and cause additional fissions. The continuing process of fissioning is known as a chain reaction.

MASTER #XI-9

NUCLEAR POWER PLANT


Generator
Turbines
Core
Reactor Vessel
Pump
Condenser
Containment Vessel

Nuclear Plants

In a nuclear plant, heat is also used to produce steam, which in turn is used to generate electricity. The main difference between a fossil plant and a nuclear plant is the source of heat. The heat in a nuclear plant is produced by a process called nuclear fission, which can occur in special types of nuclear fuel.

MASTER #XI-10

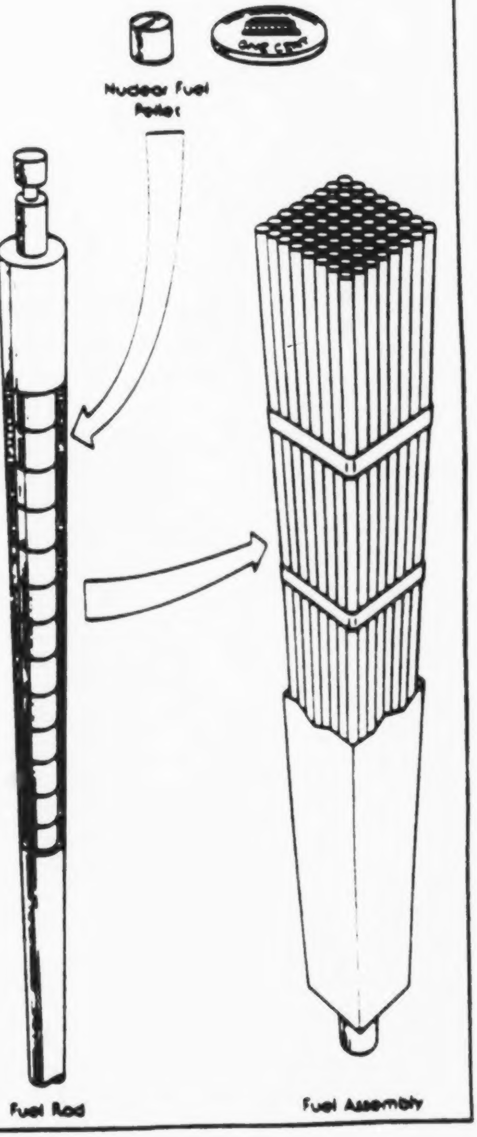
NUCLEAR FUEL

Nuclear Fuel

Only a few elements fission easily enough to be used as fuel in a nuclear power plant. Of these special materials, uranium is the most common fuel in today's reactors.

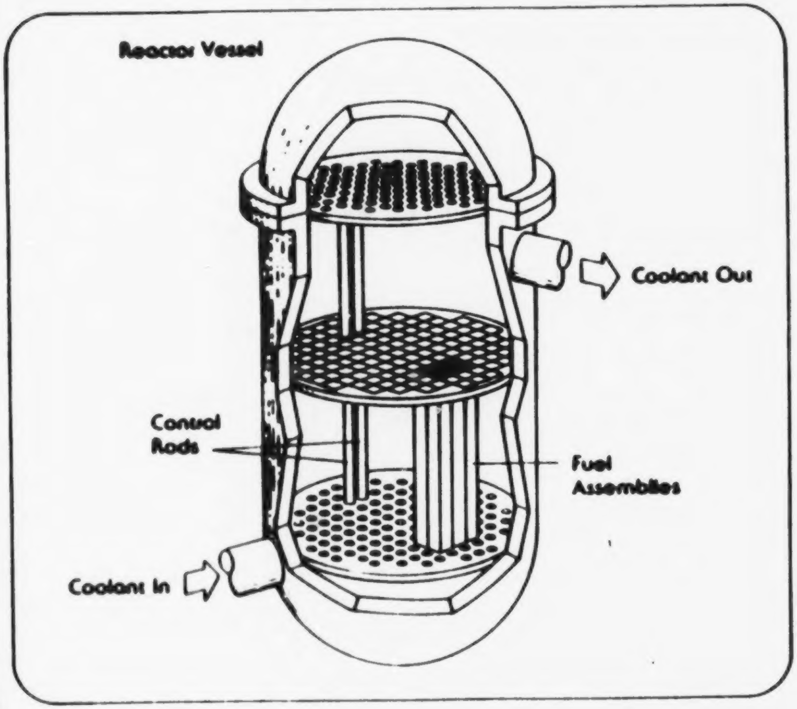
Any nuclear fuel, including uranium, must be processed through several steps before it can be used in a reactor. The fuel must first be carefully refined. It is then shaped into small cylinders known as fuel pellets. The pellets are less than 1/2 inch in diameter, but each one can produce as much energy as 120 gallons of oil.

Fuel pellets are stacked and sealed in hollow tubes about 12 feet long. The filled tubes are called fuel pins or rods. The rods are grouped together in bundles known as fuel assemblies. The fuel rods are carefully spaced in the assemblies to allow a liquid coolant to flow between them.



MASTER #XI-11

NUCLEAR REACTOR VESSEL


Reactor Vessel
Coolant Out
Control Rods
Fuel Assemblies
Coolant In

Reactor Vessel

The entire reactor core, which contains fuel assemblies and control rods, is enclosed in a heavy stainless steel vessel. To ensure safety, the entire reactor vessel is housed in a reinforced concrete structure.

A liquid coolant is pumped into the reactor vessel through the core to remove heat. The coolant is then pumped out of the reactor vessel and is used to produce steam. Most of the nuclear power plants in the United States use water as a coolant. These plants are known as Light Water Reactors (LWR's).

Unit XII
Meteorology.

ACTIVITY #1

TITLE: THE EARTH'S ATMOSPHERE

PURPOSE:

To examine the characteristics of the regions of the Earth's atmosphere.

OBJECTIVE:

Students should be able to:

(1) Identify the regions of the Earth's atmosphere.

(2) Describe the composition, temperature and depth of each region.

(3) Identify the global air currents and indicate the direction of their circulation.

MATERIALS:

Masters #XII-1 and #XII-2

PROCEDURE:

(1) Prepare a transparency of Master #XII-1 and student copies with labels omitted.

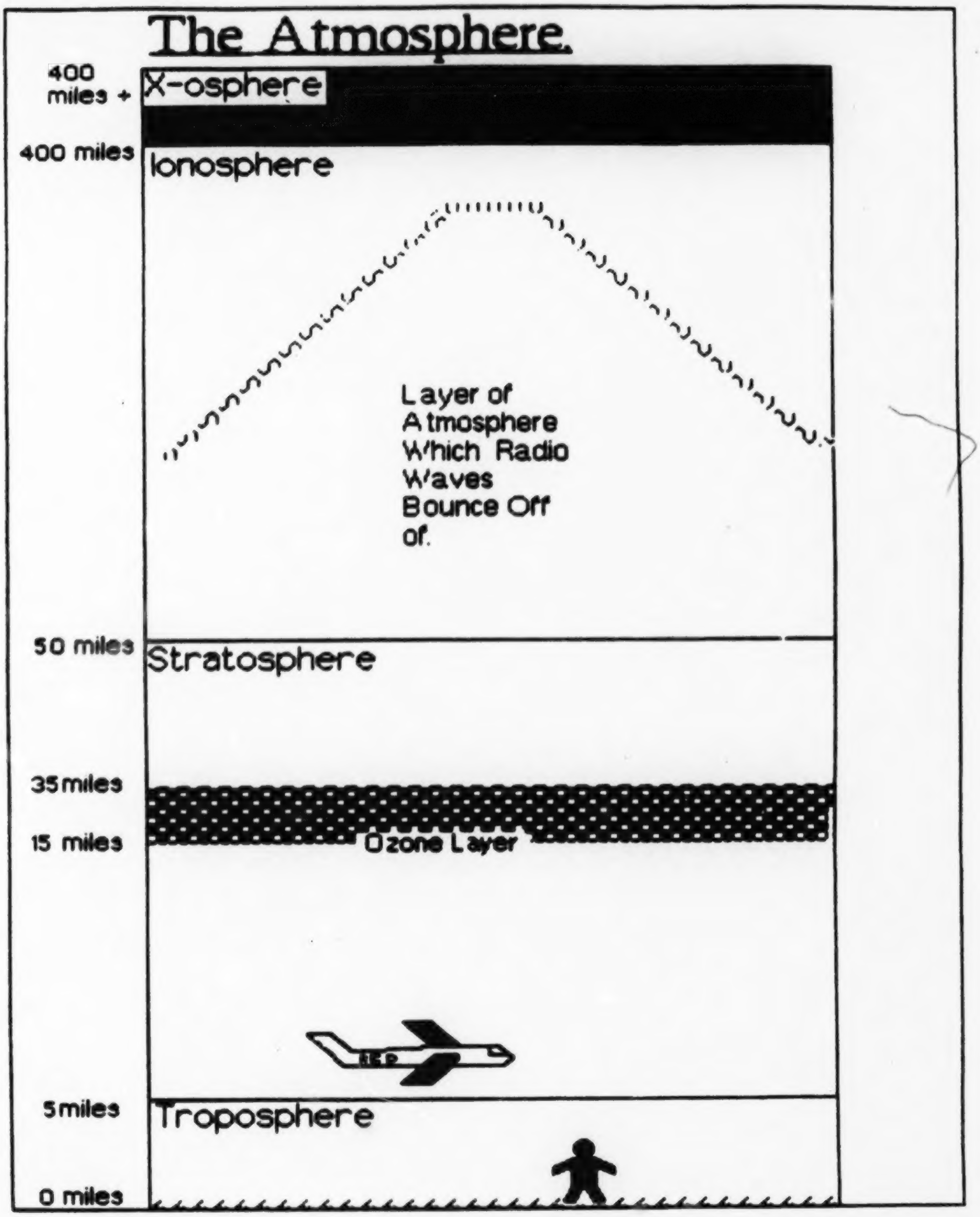
 (a) Have students record the name of each region on their diagrams.

 (b) Provide students with information on the composition, depth and temperature of each region.

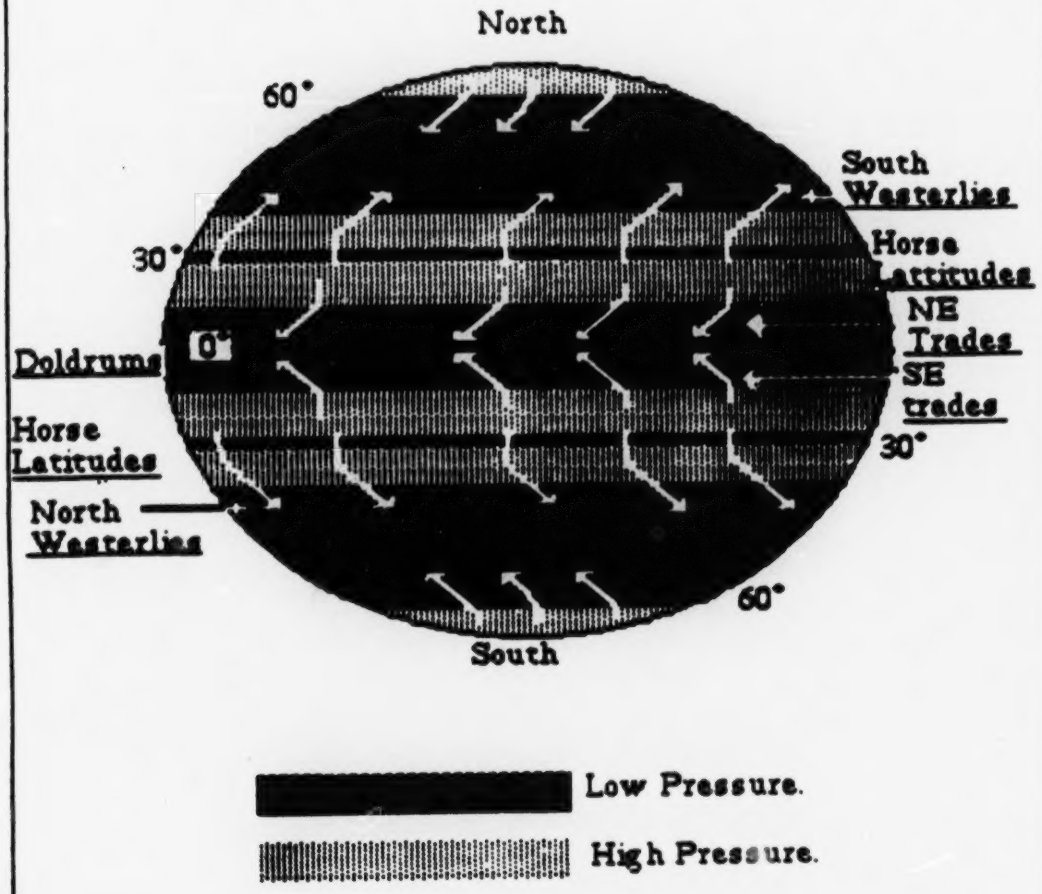
(2) Prepare a transparency of Master XII-2 and student copies with labels omitted.

- (a) Have students record the names and locations of the Earth's air currents on their diagrams.
- (b) Describe to the students the directions which the air currents move and the principle behind this motion (Coriolis force).
- (c) Indicate the characteristics of the air currents to the students.
- (d) Discuss the influence of the ocean on climate conditions in the U.S.

MASTER # XII-1


The Atmosphere
400 miles +
X-osphere
400 miles
Ionosphere
Layer of Atmosphere Which Radio Waves Bounce Off of.
50 miles
Stratosphere
35 miles
15 miles
Ozone Layer
5 miles
Troposphere
0 miles

MASTER #XII-2


North
60°
South Westerlies
Horse Latitudes
30°
NE Trades
Doldrums
0°
SE trades
30°
Horse Latitudes
North Westerlies
60°
South
Low Pressure.
High Pressure.

ACTIVITY #2

TITLE: WEATHER FRONTS AND PRESSURE SYSTEMS

PURPOSE:

To examine the formation of weather fronts and pressure systems.

OBJECTIVE:

Students should be able to:

(1) Diagram and describe the formation of cold, warm, and occluded fronts.

(2) Predict the type of weather pattern associated with each front.

(3) Diagram and describe the characteristics of high and low pressure systems.

MATERIALS:

Masters #XII-3 and #XII-4

PROCEDURE:

(1) Prepare a transparency of Master #XII-3 and student copies with labels omitted.

  (a) Have students label position of air masses and cloud types of diagram as teacher presents information on cold, warm and occluded fronts.

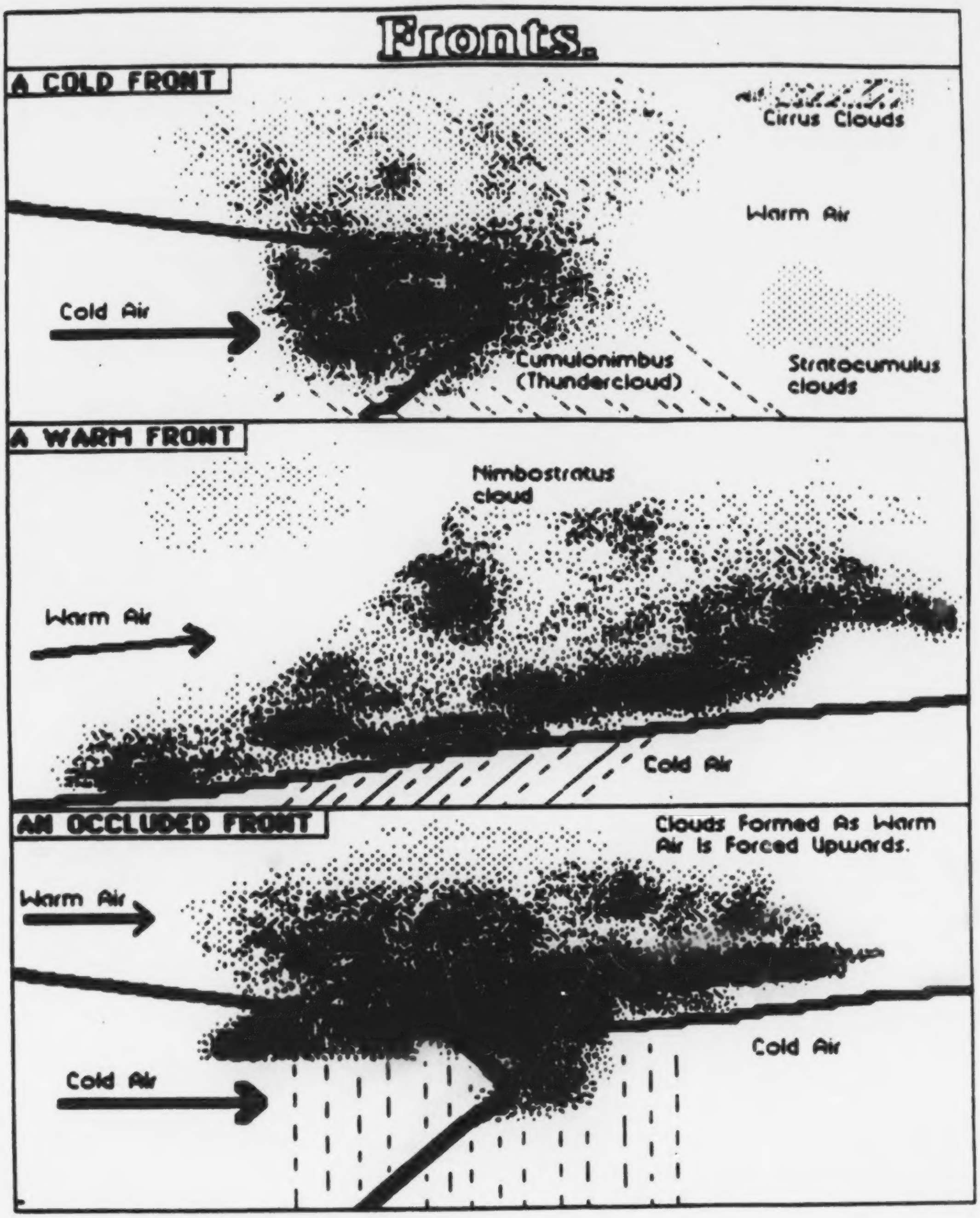
  (b) Describe the weather conditions associated with each front and have students record information in notes.

(2) Prepare a transparency and student copies of Master #XII-4.

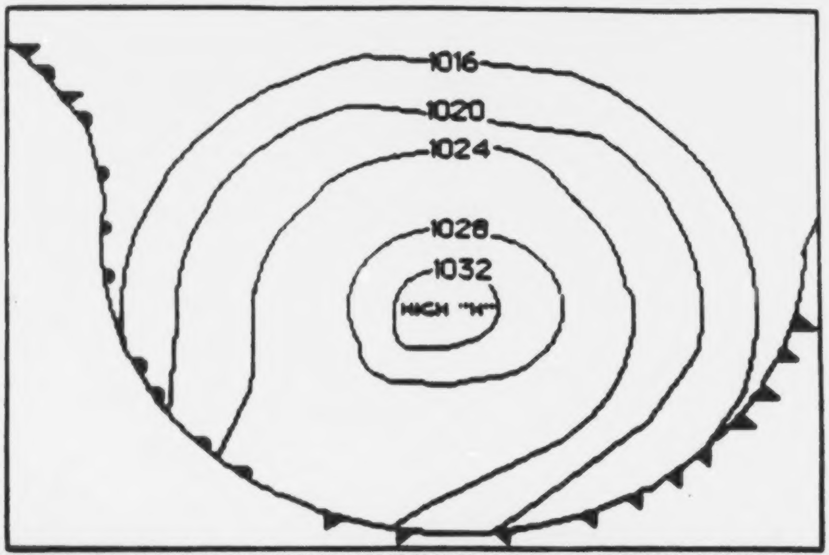
  (a) Have students examine the pressure system diagrams and observe the wind circulation of each system.

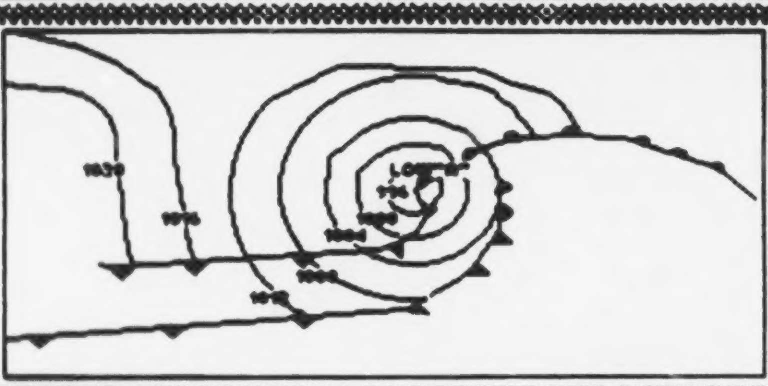
  (b) Describe the weather conditions and barometric pressures associated with each system.

MASTER $ XII-3


Fronts.
A COLD FRONT
Cirrus Clouds
Warm Air
Cold Air
Cumulonimbus (Thundercloud)
Stratocumulus clouds
A WARM FRONT
Nimbostratus cloud
Warm Air
Cold Air
AN OCCLUDED FRONT
Clouds Formed As Warm Air Is Forced Upwards.
Warm Air
Cold Air
Cold Air

Highs And Lows.


1016
1020
1024
1028
1032
HIGH "H"



Key:

Warm Front: —◗—◗—◗—
Cold Front: —▲—▲—▲—
Axis Of Trough: ————
Occluded Front: —▲◗▲◗▲—

ACTIVITY #3

TITLE: NATURAL DISASTERS

PURPOSE:

To make students aware of the nature of natural disasters.

OBJECTIVE:

Students should be able to:

(1) Describe the condition, location and occurrence of five natural disasters.

(2) Describe the causes and effects of natural disasters.

(3) Prepare a list of measures to take to protect life and property from natural disasters.

MATERIALS:

Fact Sheets #1-#5

PROCEDURE:

(1) Break the class into five study groups and assign studies of (1) tornadoes, (2) hurricanes, (3) floods, (4) blizzards, and (5) earthquakes.
Give each group an information sheet discussing the kind of disaster the group is studying.

SUGGESTED GROUP ACTIVITIES

(a) Define the natural disaster studied.

(b) Make a group map of the United States to show areas in which the natural disaster being studied is likely to occur.

(c) Discuss the causes and effects of the designated disaster.

(d) Prepare a list of measures to take to protect life and property from the designated disaster.

(e) List personal experiences of any group members that have encountered the designated disaster.

(f) List protective measures common to nuclear disaster and the natural disaster being studied.

(2) Arrange for a visit by an official from the local office of civil preparedness to learn how it functions in the face of natural disasters.

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FACT SHEET I

TORNADOES

DEFINITION: A tornado is the most violent weather phenomenon known to man. A tornado is also called a "twister" and, incorrectly, a "cyclone." It is a small storm that usually appears as a funnel-shaped cloud rotating rapidly and tapering toward the ground, within which wind velocities have been estimated at speeds up to 500 miles per hour. Generally, its path covers only a small area, being usually no more than 1/4 mile wide and from 15 to 20 miles in length. However, tornadoes have been observed having a width of one mile and up to 300 miles in distance on the ground. Normally, the tornado lasts only a short time as it moves forward at approximately 25 to 40 miles per hour. Generally, tornadoes move from southwest to northeast, but some have been known to travel in other directions.

WHERE THEY STRIKE: Tornadoes may strike any part of the United States. All of the adjoining 48 states and the District of Columbia have felt the fury of these storms at one time or another. The areas most likely to be stricken, however, lie within the central part of the United States.

WHEN THEY STRIKE: The time of day most favorable for tornadoes is from noon to midnight; it is during this period that 82 percent of the observed and reported tornadoes have occurred. They may strike, however, at any hour. At any given location within the ground path of a tornado, the storm will strike and move on in the space of one or two minutes. But hazards created by the resulting storm damage may continue. Walls left standing in a dangerous condition or broken electrical power lines lying on the ground are threats as long as persons are exposed to them.

FACT SHEET II

HURRICANES

DEFINITION: Hurricanes are tropical cyclones that form near the Equator. They form over all of the tropical oceans except the South Atlantic, but not over the continents. In the western North Pacific Ocean, they are known as typhoons; in the Bay of Bengal and the northern Indian Ocean, as cyclones; in the South Pacific, eastern North Pacific, southern Indian and North Atlantic Oceans (including the Gulf of Mexico and Caribbean Sea), they are known as hurricanes. Hurricanes in Australia are sometimes called willy-willys and the typhoons of the Philippines, Baguios. All are of the same general character and, as a class, are known as tropical cyclones.

The hurricans is the most powerful of all storms. Wind velocities must reach 74 miles per hour or higher before a disturbance can be called a hurricane. Although this velocity is considerably less than that of a tornado, the hurricane is a much larger storm and affects an area for a much greater time period. The diameter of a hurricane varies greatly. In some cases, it is not more than 50 to 75 miles; but in the majority of cases the diameter is greater, and in many instances has exceeded 500 miles as compared to 1/8 to one mile diameter of a tornado. Furthermore, the hurricane may carry its destruction over a path many hundreds or even thousands of miles in length; whereas tornadoes usually travel from 15 to 20 miles, with a maximum of nearly 300 miles.

WHERE THEY STRIKE: Hurricanes form over tropical oceans where there is an abundance of moisture in the warm air. The Atlantic Ocean, the Caribbean, or the Gulf of Mexico is the birthplace of practically all of the hurricanes that affect the United States, although a few will form in the eastern Pacific off the Central America coast and move west or northwestward. These seldom reach the California coast, but have affected Hawaii. Hurricanes generally move toward the west at first, and then curve gradually northward. Following this course, hurricanes strike the United States along the coast of the Gulf of Mexico or the Atlantic Ocean. Hurricanes moving inland from the Atlantic Ocean have ranged from the southern limits of Florida to as far north as the New England States. Hurricanes usually weaken and dissipate before traveling far inland; but they can cause severe inland floods because of the heavy rains they bring. Thus, it is the coastal areas from Texas to Florida and from

Florida to New England which face the greatest threat of hurricane disaster.

WHEN THEY STRIKE: Hurricanes are most likely to strike from late summer to early fall in the western hemisphere. When the storm appears to be 30 to 36 hours away from the United States, a "hurricane watch" is announced. A "hurricane warning" is issued when winds reach 74 miles per hour, or dangerous high water or rough seas are expected in the specified coastal area within the next 24 hours.

FACT SHEET III

FLOODS

DEFINITION: A flood is defined as water that covers land not usually under water. Floods destroy property, disrupt normal activities and services, carry away topsoil and crops, and endanger life. While lakes, seas, and oceans sometimes flood coastal areas, most floods are caused by rivers overflowing their banks. The damage stage of a flood is usually reached when the river's banks are full and the overflow begins to cover the flood plain. Flood plains may be very narrow in mountainous regions or miles wide where a river's course is through flat lands. Sometimes floods are beneficial, as in the case of the Nile River and in the rich soil deposited in the delta regions of many rivers. Despite modern methods of prediction and warning, floods still constitute major disaster threats for many parts of the world and for millions of people.

WHERE THEY STRIKE: All low-lying coastal areas near large bodies of water and the land near rivers are subject to flooding at almost any time. The entire United States east of the 90th meridian is subject to periodic floods. The Mississippi-Missouri River system and its feeders, for example the Ohio, often cause major floods that cover millions of acres of land. Floods are not uncommon in New England, along the entire Atlantic Coast (especially in hurricane season), in the Far West, and along the Gulf Coast. Losses from floods in this country average $300 million each year. Flash floods caused by heavy rains or sudden thaws may even effect normally dry areas such as the Southwest and the Rocky Mountain States. Despite flood control efforts, such as planting trees in watersheds, and building reservoirs, no area near a large river can be made completely flood proof.

WHEN THEY STRIKE: The usual causes of river floods include too much rain at any one time and the rapid melting of ice and snow. Floods from seas or lakes are usually caused by winds piling up water against the coast line (see Fact Sheet II on hurricanes), and occasionally by earthquakes or volcanic eruptions, which may cause tidal waves. Therefore, times of heavy rainfall, the spring thaw, and the hurricane season often produce floods. The U.S. Weather Bureau issues flood warnings for more than 1,000 places in the United States and uses radar to spot heavy rain areas that may cause flash floods.

FACT SHEET IV

BLIZZARDS

DEFINITION: A blizzard is a winter storm which brings extremely cold weather, strong winds, and blowing snow. Temperatures may fall 10 to 20 degrees per hour, reaching lows of 20 to 30 degrees below zero. Winds of 50 to 60 miles an hour may fill the air with fine, powdery snow that create deep snowdrifts, and reduce visibility to a minimum. Persons caught outside by the storm may even find difficulty in breathing. The snow which is driven by the wind may be falling from a cloud, or it may be that which is picked up from earlier snowfalls.

WHERE THEY STRIKE: Blizzards generally form in the Rocky Mountain and Plains States of North America where there is an abundant supply of cold air during the winter. They are usually produced when cold, polar air is drawn into active low-pressure disturbances. Conditions favorable to the occurrence of a blizzard can be forecast quite accurately. The onslaught of a storm may be sudden, however, and its ferocity may increase rapidly.

Lands which lie westward from the Great Lakes are most likely to be stricken. This area includes the states of North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, eastern Montana, and eastern Wyoming. Blizzards may strike anywhere within the Plains States and Middle West, however, and as far southward as Texas. They are rare in the Northwest, and virtually unknown in the Deep South and Far West, except in the highlands. Heavy snowstorms are a threat from the Great Lakes eastward, however, and cold waves may reach as far southward as the Florida peninsula.

WHEN THEY STRIKE: Late fall through the winter and into early spring.

FACT SHEET V

EARTHQUAKES

DEFINITION: An earthquake is caused by a sudden displacement within the earth. Displacement at relatively shallow depths may be caused by volcanic eruptions, or even by avalanches. The resultant earthquakes are usually light and do little damage. Strong and destructive earthquakes usually result from the rupturing or breaking of great masses of rocks far beneath the surface of the earth. The ultimate cause of these deep ruptures has not been established.

WHERE THEY STRIKE: Two-thirds of all earthquake activity in the United States occurred in the Pacific Coast States and nearby portions of Nevada. Within this region, the area of greatest earthquake frequency is in the Coastal Ranges of central and southern California, extending from the San Francisco Bay area southeastward to the vicinity of Los Angeles. Elsewhere along the Pacific coast, earthquake activity is relatively great along the coast of Northern California and in the Puget Sound lowland of the State of Washington.

Within the states of the western interior, a zone of earthquake activity extends from Montana southward into northern Arizona. The central part of the United States is not an area of great earthquake frequency. The greatest concentration of shocks has been in eastern Missouri and nearby states. In the eastern United States, earthquakes have been scattered widely, and most have been only minor.

Alaska has many earthquakes, especially in the south. The major earthquake belt in Alaska extends through the Aleutian Islands, the Alaska Peninsula, and into the Kenai Peninsula, and it extends inland several hundred miles into Fairbanks.

WHEN THEY STRIKE: It is not yet possible to forecast an earthquake, to any useful degree. Seismologists are well aware of the areas where earthquakes are likely to strike, but are generally unable to predict the day, week, or even the month when an earthquake will strike.

ACTIVITY #4

TITLE: NATURAL DISASTER READINESS

PURPOSE:

To make students aware of the nature of natural disasters and civil preparedness measures taken to prepare them to meet such disasters, and to allay fear.

OBJECTIVE:

(1) Students should be able to explain the nature of natural disasters and the destruction that can result.

(2) Students should be able to solve a simulated disaster problem.

MATERIALS:

Masters #XII-5 and #XII-6

PROCEDURE:

(1) Solve blizzard disaster simulation.

- (a) Prepare transparencies and student handouts of Masters #XII-5 and #XII-6.
- (b) Divide students into groups of 4 or more.
- (c) Have each group develop solutions to guide questions for simulation.
- (d) Have each group present their solution and then develop a total class solution.

NOTE: In distribution of population avoid using the following areas: #'s 3,5,9,10,11. Use #1 for smoking, #4 for headquarters, and #6 for food distribution. Clear area #8 of all tables and arrange shelterees in rows and establish a first aid station.

Major personal needs to consider:

Food & Water
Temperature & Humidity
Sleep
Illumination
Noise
Religious Activity
Ventilation
Odors
Health
Communication
Recreation
Security

(2) Develop a class list of generalized rules governing conduct on a shelter.

(3) Break class into five study groups, and assign studies of (1) tornadoes, (2) hurricanes, (3) floods, (4) blizzards, (5) earthquakes. Give each group an information sheet discussing the kind of disaster the group is studying. Library study should supplement the information sheets. Each group should then prepare a report for class presentation.

(4) Invite a member of the staff of the local Weather Bureau to speak to the class on how natural disasters are predicted.

(5) Have a member of the local civil preparedness agency speak to the class on local emergency readiness in the event of natural or nuclear disasters.

Survival Case Study.

A blinding snowstorm has paralyzed the Northeast. Traffic slowed, sputtered, then stopped. And so did you on the New Jersey Turnpike in the stretch between the New Brunswick and Hightstown exits. You fight your way through the wind, cold and drifting snow to the nearest rest area. You notice many other temporarily abandoned cars, trucks and buses. When you arrive at the restaurant all is confusion. It is jammed with people - approx. 800. It is designed to host about 200 in a fluid flexible way. But people aren't leaving. They've no place to go!

They shout their orders to the harried restaurant staff. They demand service. Service is slow, but tempers are fast. The frantic restaurant manager is incapable of handling the emergency. He doesn't know what to do You ask if you can take over. He agrees and seems greatful.

You climb on the counter next to the cashier's booth and call for attention. Surprisingly, you get it. The people seem anxious for leadership and you've volunteered. Now that you have the job - what are you going to do?

Despite the over crowded conditions of the establishment, all is not futile. The manager indicates that the store rooms hold a 5-6 day food supply. the emergency generator took over automatically when the area power supply failed. Though full power is not available, there is enough. The stoves burn butane gas and there is a week's supply on hand. On the turnpike, near the restaurant, among the many stalled vehicles are a milk truck, a bread truck, and a truck filled with quilts. The truckers place them at your disposal.

This case study is fiction based on fact. It is not a hypothetical situation. It really happened and...

IT COULD HAPPEN AGAIN!!!

Student questions:

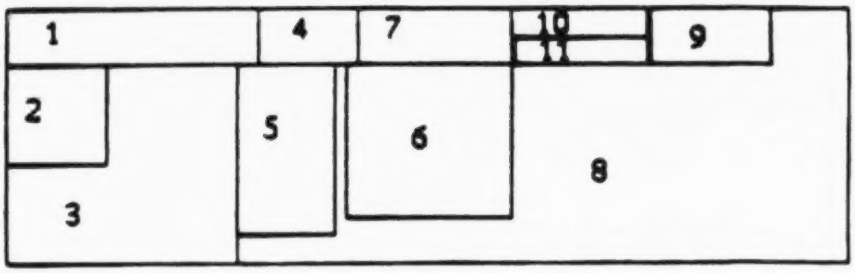
1. How would you use the space available to distribute your population?
2. What "people needs" would you consider in your planning?
3. Smoking could be a problem in such crowded quarters. How would you handle this problem?
4. What would be some of the problems in food service? How would you solve them?
5. Many rumors have been started about people being stranded and dead in their cars out on the Turnpike. What would you do?
6. What would you do to keep air from fouling?
7. You fear that liquor may cause problems among the shelterees. What would you do?
8. What problems in sleeping do you foresee? What would you do to solve the problem?
9. You fear that drugs may cause problems among shelterees. What would you do?

Shelterees.

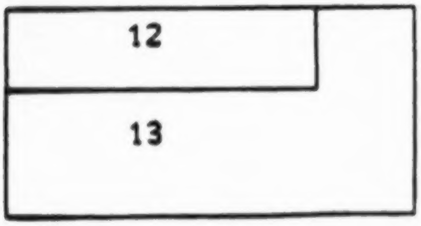
8 Restaurant employees
4 Gasoline station employees
200 Truck drivers
6 Bus drivers
3 Physicians
3 Nurses
2 Ambulance drivers
4 Ministers
4 Nuns

10 Servicemen
20 Rock & Roll stars
15 College students
40 Teenagers
40 Aged 12 or under (7 infants)
13 Suffering from exposure
1 Child with croup
2 Diabetics

This is the space available.



1. Grease racks
2. Gasoline sales office
3. Gasoline storage rack
4. Restaurant office
5. Men's rest room
6. Counter space
7. Kitchen
8. Dining area
9. Ladies' rest room
10. Freezer space
11. Storage room
12. Boiler room
13. Basement and storage area



ACTIVITY #5

TITLE: **WEATHER FORECASTING**

PURPOSE:

To examine the meteorological instruments, and systems utilized in forecasting weather.

OBJECTIVE:

Students should be able to:

(1) Identify and explain the use of meteorological instruments.

(2) Identify and describe the function of weather satellites.

(3) Make a weather forecast for the local region.

MATERIALS:

Weather maps of the U.S.
Library resources (meteorology)

PROCEDURE:

(1) Divide the class into two groups for library research on meteorology.

  (a) Assign one group to research the instruments used in weather forecasting.

  (b) Assign the other group to research the types of weather satellites used in weather forecasting.

  NOTE: Have each group present oral reports on their research.

(2) Distribute weather maps to students.

  (a) Have students plot a weather system for a four or five day period using U.S. Weather Bureau maps published in the daily newspaper.

(b) Have students check accuracy of local forecast for a five day period.

(c) How did the weather systems plotted effect local weather?

(d) Ask students the following questions:

  - Should we scientifically attempt to change local weather patterns?
  - What is the importance of knowing the weather?